REPORT

ON THE

PROGRESS OF AGRICULTURE IN INDIA

FOR

1918-19

00134318

CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1920

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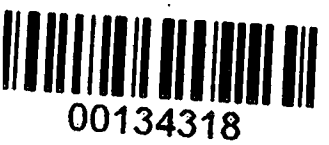

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NOTE.

THE annual reports of the North-West Frontier Province and of the Indian States of Kashmir, Baroda, Travancore and Gwalior have not been received in time to permit of reference to the work in their agricultural departments being included in this review.

CAMP CALCUTTA,
January 15th, 1920.

J. MACKENNA,
Agricultural Adviser to the Government of India.

Report on the Progress of Agriculture in India for 1918-19.

CHAPTER I.

PROGRESS IN ADMINISTRATION.

(*a*) The Agricultural Adviser.

I held charge of the office of the Agricultural Adviser to the Government of India up to the 2nd October, 1918, and again from the 4th November, 1918, to the 12th April, 1919, when I proceeded on six months' privilege leave. Dr. W. H. Harrison, Imperial Agricultural Chemist, acted for me from the 3rd October to the 3rd November, 1918, and Mr. G. A. D. Stuart, I.C.S., Director of Agriculture, Madras, from the 13th April, 1919. A change was made in the organization of the Agricultural Research Institute, Pusa, on its administrative side, by the appointment of Dr. E. J. Butler, M.B., F.L.S., from the 20th January, 1919, as Joint Director in addition to his own duties as Imperial Mycologist; and the post of Assistant to the Agricultural Adviser, previously held by Mr. Wynne Sayer, has been temporarily placed in abeyance.

Tours. My opportunities of touring in the provinces were greatly curtailed by pressure of administrative work, particularly in connection with the proposals for the expansion and reorganization of the department and the measures taken for the control of the distribution of food-grains after the failure of the 1918 monsoon. I visited, however, the farms at Bankipore, Sabour and Ranchi in the province of Bihar and Orissa, and at Coimbatore in Madras. I also attended a meeting of the

Bihar Planters' Association at Muzafferpur, two meetings of the Surra Committee at Simla and Lahore, the Co-operative Conference at Simla, the meetings of the Board of Scientific Advice in India at Delhi, the Indian Science Congress at Bombay and the meeting of veterinary officers at Lahore. I also went to Calcutta to confer with certain firms interested in the jute trade, and to Bombay to discuss matters relating to the Indian Cotton Committee's report.

(*b*) War Services of the Staff.

Of the officers of the agricultural and veterinary departments whose names were mentioned in the last year's report as performing duties in connection with military operations, all returned to their civil duties during the year under review, except four agricultural department officers, *viz.*, Mr. Roger Thomas (Madras), Mr. Thomas Gilbert (Bombay), Dr. A. E. Parr (United Provinces), and Mr. R. J. D. Graham (Central Provinces).

The names of the undermentioned officers were brought to the notice of the Government of India for valuable services rendered in connection with the war up to the 31st December, 1918:—

(1) Colonel G. H. Evans, C.I.E., C.B.E., Superintendent, Civil Veterinary Department, Burma.

(2) Colonel H. T. Pease, C.I.E., V.D., Principal, Veterinary College, Punjab (since retired).

(3) Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., Principal, Veterinary College, Punjab.

(4) Captain (Temporary) G. C. Sherrard, Deputy Director of Agriculture, Bihar and Orissa.

(5) The Hon'ble Mr. H. R. C. Hailey, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.

(6) Mr. B. C. Burt, M.B.E., Deputy Director of Agriculture, United Provinces.

(7) Colonel J. Farmer, C.I.E., Chief Superintendent, Civil Veterinary Department, Punjab.

(8) Mr. J. G. Cattell, Superintendent, Civil Veterinary Department, Sind, Baluchistan and Rajputana.

Colonel G. H. Evans, Lieutenant-Colonel G. K. Walker and Mr. B. C. Burt received their appointments as Companion, Officer and Member, respectively, of the Most Exalted Order of the British Empire, for services rendered in connection with the war; while the good work of Lieutenant (Temporary Colonel) Geoffery Evans as Director of Agriculture in Mesopotamia was recognized by his appointment as an additional Companion of the Most Eminent Order of the Indian Empire.

(*c*) Changes in the Personnel of the Staff.

Changes in *personnel* have been few and mainly confined to officiating arrangements consequent on the grant of leave to officers who could not be spared from service during the period of the war. The depletion of staff thus caused has, as usual, been met either by doubling up charges or by promoting Indian assistants to temporary charge. Five Indian officers of the Provincial Agricultural Services have been promoted to the Indian Agricultural Service during the year, and one has been appointed direct to the latter service.

A comprehensive dairy and cattle-breeding scheme involving the appointment of three officers of the superior grade has been sanctioned and budget provision has been made to bring it into effect next financial year. Posts of a supernumerary mycologist, a bacteriologist, an economic botanist and a protozoologist have been added to the Imperial Department, while two temporary posts of mycologists have been sanctioned for the Madras department to assist the planting industries. Further, proposals have been submitted to the Secretary of State for India for thirty-seven additional posts in the Indian Agricultural Service to meet the general expansion of the department which is now so urgently needed.

The changes in the *personnel* of the Imperial and Provincial Departments of Agriculture are dealt with below. For those of the Civil Veterinary Department and the Imperial Bacteriological Laboratory, Muktesar, reference should be made to pages 120-127.

(i) The Staff in the Imperial Department.

Dr. E. J. Butler, Imperial Mycologist, was on deputation to the Federated Malay States, to report on the Agricultural Department there, from the 8th July to the 13th November, 1918. During his absence Dr. F. J. F. Shaw officiated as Imperial Mycologist, and Mr. J. F. Dastur, then First Assistant of the Mycological Section, acted as Second Imperial Mycologist. Mr. Dastur has since been appointed to the Indian Agricultural Service as Supernumerary Mycologist and deputed to England for fifteen months' training.

Mr. G. S. Henderson was confirmed in the appointment of Imperial Agriculturist from the 1st March, 1918. On the termination of his temporary duties as Controller (Agricultural Requirements, Mesopotamia) under the Indian Munitions Board, on the 22nd June, 1919, he proceeded on six months' combined leave. Mr. Wynne Sayer has been officiating for him as Imperial Agriculturist from the 20th January, 1919.

Mr. F. M. Howlett, Imperial Pathological Entomologist, was deputed for a period of six months from the 24th January, 1919, under the Indian Research Fund Association to conduct experiments with mosquito repellents.

Mr. J. H. Walton, on the termination of his duties under the Military Department, reverted to his appointment of Supernumerary Agricultural Bacteriologist on the 10th April, 1919.

Captain W. Hodgkinson, R.E., worked, in collaboration with the Imperial Agricultural Bacteriologist throughout the year, on electrical methods of water sterilization.

Mr. J. Sen, Supernumerary Agricultural Chemist, continued throughout the year on deputation under the United Provinces Government.

Mr. M. Afzal Hussain, who has been appointed to the Indian Agricultural Service, was posted to Pusa as Supernumerary Entomologist from the 6th January, 1919.

(ii) The Staff in the Provincial Departments.

In Madras, Mr. G. A. D. Stuart made over the charge of the office of Director of Agriculture to Mr. R. C. Wood of the

Indian Agricultural Service in April 1919. Mr. E. Ballard returned from military duty and resumed charge of the office of Government Entomologist. Messrs. P. H. Rama Reddi and R. C. Broadfoot were admitted into the Indian Agricultural Service and appointed as Deputy Directors of Agriculture. Messrs. Hilson and Parnell proceeded on combined leave, and Dr. C. A. Barber took six months' leave from 12th April, 1919, preparatory to retirement. Dr. Barber's retirement from service is a great loss to Indian agriculture and particularly to the sugar industry. He has done work of first importance in connection with sugarcane, and his personality was the mainspring of the Cane-breeding Station at Coimbatore to the results of which we look for future progress in sugarcane cultivation.

In Bombay, Dr. H. H. Mann took over charge of the office of Director of Agriculture from Mr. G. F. Keatinge, I.C.S., in November 1918, Mr. Knight succeeding Dr. Mann, as Principal of the Agricultural College at Poona. Mr. P. C. Patil was promoted to the Indian Agricultural Service as a Deputy Director of Agriculture, and Mr. H. M. Chibber was appointed to the post of Plant-breeding Expert.

In the United Provinces, Messrs. H. M. Leake and B. C. Burt were on leave for a part of the year, and Mr. W. N. Harvey, on return from military duty, resumed charge of the Eastern Circle. The term of the appointment of Mr. W. Hulme, Sugar Engineer, was extended for another season, and on completion of the season's work, his services terminated on the 7th April, 1919.

In Bengal, Mr. K. McLean returned from military duty early in February and resumed charge of his duties as Deputy Director of Agriculture, Eastern Circle. Mr. Rajeswar Das Gupta was promoted to the Indian Agricultural Service and was posted as Deputy Director of Agriculture, Northern Circle. Mr. Annett, Agricultural Chemist, remained on deputation in connection with the improvement of the morphine content of Indian opium, and Mr. F. Smith, Deputy Director of Agriculture, Western Circle, proceeded on combined leave for 14 months from January 1919.

In Bihar and Orissa, Mr. A. C. Dobbs has relieved Mr. G. Milne, I.C.S., of the charge of the Director of Agriculture,

which he holds in addition to his own duties as Deputy Director of Agriculture, Chota Nagpur. Mr. G. C. Sherrard, Deputy Director of Agriculture, on return from military service, was placed on special duty in connection with the closing of the Bankipore farm and the opening of new farms at Purulia, Ramgarh (Hazaribagh) and Netarhat. The services of Mr. D. R. Sethi, Deputy Director of Agriculture, Orissa Circle, were placed at the disposal of the Durbar of the Kapurthala State in the Punjab for three years, with effect from the 5th December, 1918, and Mr. S. K. Basu was appointed to officiate for him. Mr. N. S. McGowan, Professor of Agriculture, took combined leave for one year from 1st April, 1919.

In the Punjab, Mr. E. A. A. Joseph, I.C.S., handed over the charge of the post of Director of Agriculture to Mr. S. M. Jacob, I.C.S., in November 1918.

In Burma, Mr. D. F. Chalmers, I.C.S., relieved Mr. English of the charge of the office of Director of Agriculture in October 1918. Mr. T. Thompstone returned from military duty and resumed charge of the Northern Circle in July 1918. Mr. Warth, Agricultural Chemist, acted as Assistant Commandant, Military Police, in addition to his own duties, till the end of September 1918, and proceeded on six months' leave on the 5th June following. The staff of the department was strengthened by the reappointment of Maung Ba Gyaw as temporary Agricultural Engineer.

In the Central Provinces, Messrs. J. H. Ritchie and F. J. Plymen returned from military duty and resumed their respective civil charges.

In Assam, Mr. A. G. Birt returned from military service in February 1919, after an absence of nearly four years, and resumed his duties as Deputy Director of Agriculture, Assam Valley, but shortly afterwards proceeded on combined leave. Mr. McKay, on completion of the term of his agreement, resigned his post of Deputy Director of the Surma Valley and Hill Districts, and Mr. J. N. Chakraburty, a Superintendent of Agriculture in Bengal, was appointed to act for him. Mr. L. Barthakur, a Superintendent of Agriculture in Assam, was appointed to act for Mr. Birt.

(*d*) Conferences.

No meeting of the Board of Agriculture in India was held during the year, but in pursuance of the recommendation made by the Board of 1917, sectional meetings of mycologists, entomologists, chemists and bacteriologists, and of veterinary officers were held in February and March 1919. A large amount of valuable work was got through and the meetings were considered an unqualified success. It was not, however, possible to hold meetings of agricultural officers owing to the depleted state of the provincial departments. The proceedings of these meetings have been published and are available to the public except those of the entomological meeting which are still in the press.

These meetings naturally deal mainly with technical questions of general application. But there are many agricultural questions of purely local importance the consideration of which can more appropriately be undertaken by Provincial Boards. Agricultural conferences are, it is true, already held in some provinces, but these are generally limited to members of the department. As indicated in last year's report, a suggestion was therefore made to Local Governments by the Government of India that the scope of such meetings should be extended to cover all interests and to enlist non-official as well as extra-departmental co-operation with a view to bring the work of the department into greater prominence and popularity. Such provincial boards have now been organized in the United Provinces, the Central Provinces and Bombay.

An informal conference to deal with several problems connected with the Pusa dairy herd was also held during the year.

CHAPTER II.

AGRICULTURAL CONDITIONS OF THE YEAR.

During the year the monsoon rains began earlier than usual but were very scanty over nearly the whole of the country except in North-east India and in Burma. The winter rainfall also was very defective. Another feature of the year was that at the most critical time of agricultural operations, *viz.*, the sowing period, a fierce epidemic of influenza raged throughout the country, took a heavy toll of the rural population and considerably depleted the agricultural labour. All these adverse circumstances seriously affected both the *kharif* (autumn) and the *rabi* (spring) crops. The area under almost all the important crops—rice, wheat, cotton, jute, indigo, linseed, sesamum, groundnut, etc.—fell heavily, while the outturns were the lowest on record during the last decade. The area under sugarcane was slightly higher than in the preceding year but, on account of the unfavourable season, the yield was 29 per cent. below that of the last year. The only crop that did well was tea which scored a record yield of manufactured product with an increase in area of about 2 per cent.

As an inevitable sequence of the long-continued drought, there was a widespread famine of food and fodder which seriously affected both men and cattle. The provincial departments concerned concentrated all their energies and resources to mitigate the effects of the drought, by lending out every available engine and pumping set, by boring wells and by the supply of seed. The famine, especially of fodder, was most acute in the Bombay Presidency, and the local department, with the help of special grants from the Local Government, did excellent work in minimizing the loss of cattle and in helping production of crops in spite of the long drought.

The value of food grains exported during the year declined by fourteen crores of rupees, while the value of cotton exported fell by twelve crores, but there was a surprising increase of ten crores of rupees in the value of jute manufactures exported.

Fortunately, the health of the cattle was generally good and epidemic diseases were less prevalent, but the fodder famine carried off a large number of the agricultural stock.

The experience of the year naturally brings to the forefront the question of what steps can be taken in advance, so far as the agricultural department is concerned, to meet famine conditions which may occur in the future, and what measures, if any, can be adopted to prevent good strains of crops going out of existence in such years. These points were discussed at the meeting of the Board of Agriculture in India, held in December 1919, and the conclusions arrived at were as follows:—

(*i*) The maximum charges for irrigation water should be reconsidered in connection with all irrigation schemes, in view of the new level of prices.

(*ii*) Each Local Government in any province, where famine conditions can be mitigated by wells, should have an efficient well-boring department under the charge of an Agricultural Engineer.

(*iii*) In connection with such well-boring department as is recommended, the cost of unsuccessful trial borings should not fall on the individual landowners in whose land they are made.

(*iv*) A systematic survey of the supplies of underground water, which can be tapped by wells or small bores, should be undertaken, as soon as possible, in areas where famine conditions can be mitigated by wells. In spite of the recommendations of the Irrigation Commission (paragraph 175) this survey has not been made to anything like the extent that is desirable, and its importance has not been fully appreciated.

(*v*) The possibilities of strainer tube-wells should be carefully investigated where there is any likelihood of their being successful.

(*vi*) Rivers and other sources of water which can be profitably utilized by pumping and other means in seasons of drought (even if at other times their employment is not likely to be profitable) should be surveyed and mapped, and the question as to whether preparations cannot be made in advance to utilize these, as fully as possible, as soon as a drought occurs, should be carefully considered.

(*vii*) The importance, for prevention of famine, of protective works such as embankments for regulating the run-off of water from land and the checking of erosion, combined in many instances with afforestation of part of the area, should be recognized.

(*viii*) In tracts of light rainfall it is of very great importance that serious investigations should be undertaken into methods of moisture conservation by which the yield of land can be increased in a normal year and the risk of failure may be minimized in a year of drought. The improvement and effective use of improved tillage instruments is one of the most effective means of attaining this end. Such investigations might be combined with botanical enquiries into the development of crops and strains of crops which, while normally giving a satisfactory yield, will grow under conditions of minimum rainfall.

(*ix*) Inasmuch as the loss during the recent famine has largely consisted in the loss of cattle, the improvement of grass areas, in all precarious tracts and in other tracts which can supply them, should be a matter for serious investigation by the Agricultural Department. This naturally involves the storage of fodder in normal years.

(*x*) An investigation should be undertaken, in each tract liable to famine, of the emergency fodder materials available and not usually utilized, and the best way of using them.

(*xi*) Facilities and concession rates on railways should be given in famine tracts for the export of cattle so as to relieve distress.

(*xii*) The experiments on grain storage conducted by Mr. Fletcher should be continued as it is considered that they promise to solve what has been a very difficult problem. Mr. Fletcher should be provided with means and staff necessary to continue this work so as to deal with larger traders' stocks.

(*xiii*) The problem of large scale storage of grain in elevators, silos or by similar methods should now be re-considered not exclusively from the point of view of the export trade and the railway movement but also from the broader aspect of avoiding the loss of grain throughout India which now regularly occurs.

(*xiv*) The statistical information which is collected for commercial crops, for which forecasts are published, should be also obtained for the main food crops of the country so that, though no forecasts are published, information may be available as to the stocks held in the country, and the statistical staff of the Directors of Agriculture should be strengthened for this purpose.

(*xv*) The problem of famine prevention and relief has now assumed a new aspect. The established policy of relief works and gratuitous relief depends for success on the existence, somewhere in India, of adequate stores of grain, while the very success of relief operations tends to obliterate the motives which, in the past, have created local stores of grain. Therefore, a special enquiry should now be made into the means whereby a sufficiency of foodstuffs can be secured even in the event of two successive monsoon failures. The best agency for making such an enquiry would be a strong Famine Commission appointed by the Government of India.

(*xvi*) The scope of the duties of Agricultural Departments during and after a famine should now be redetermined in the light of the present development of these departments.

CHAPTER III.

PROGRESS IN SCIENTIFIC RESEARCH.

(*a*) Agriculture and Botany.

On the agricultural side, our main work on crops consists of variety tests, manurial tests and cultural tests, while on the botanical side, attention is chiefly devoted to plant-breeding by selection and hybridization with the object of obtaining high-yielding strains resistant to diseases and suitable to the diverse conditions prevalent in different localities. Besides these, problems relating to soil drainage, the water requirements of crops, the breeding of cattle, sheep and goats on mixed farming systems, the drying of vegetables, fruit-packing, etc., are being studied.

Although a good deal of valuable work has been done by the department towards the production of better crops and a considerable amount of success has already been achieved in this direction, the economic upheaval which has resulted from the war has thrust agriculture to the forefront and intensified the demand for higher production. An extensive cultivation of selected strains and the adoption of the improved cultural methods worked out and recommended by the department will no doubt raise the average yield of most of our crops, but they will not finally solve the problem. Heavy-yielding varieties tend to exhaust the productive power of the soil. The means of our cultivators are very limited and, in most cases, they do not permit any outlay on the expensive fertilizers necessary for supplementing deficiencies of the soil. We are, therefore, faced with the necessity of tracing out the factors, inherent in the soil, economic or biological, which determine fertility under the conditions imposed by our climate, and, if possible, of bringing them under control. This aspect of the problem will receive more attention in future.

Rice. The total area under this crop was 75,864,000 acres during the year as against 80,141,000 acres* in the preceding year. The total yield was 23,672,000 tons as compared with

*Corrrected figure.

36,236,000 tons* in 1917-18. There was a drop of 314 lb. in the average yield per acre, as compared with the yield of the preceding year, on account of the failure of the crop over extensive areas. The total exports during the year amounted to 2,018,000 tons, which was 4 per cent. above the preceding year but 16 per cent. below the pre-war quinquennial average. The value of these exports was Rs. 22,96 lakhs, as against Rs. 20,66 lakhs in 1917-18, but of this increase, Rs. 1,47 lakhs was due to variations in prices prevailing during the two years under comparison.

Around the head of the Bay of Bengal lies one of the greatest rice-producing tracts of the world extending over some 21,000,000 acres, and the chief work of Mr. Hector, the Economic Botanist of the **Bengal** Presidency, has naturally been concerned with this crop. The work of classifying and testing the *aus* (early) and the transplanted (late) varieties of rice has been continued, and a beginning has been made with deep-water rice which is mostly found in the low-lying areas in the east and the south-east of the province. With this work, the bulk of the crop will have been surveyed and the best yielding races of each of the main groups will have been made available to the cultivator. The *Indrasail* variety still stands amongst the best of the transplanted *aman* paddies. It has done exceedingly well and has successfully contested the field in several localities where it was not expected to compete with local varieties. Its inherent merits have gone far to establish it in Bihar also, where a large demand for its seed has sprung up. Localities with brackish water are, however, apparently unsuitable for it. About 1,465 cwt. of seed of this strain was distributed in 10 lb. lots. It is estimated that not less than 250,000 acres were under this type in the year under review. As it yields about 3 maunds per acre more grain than the average of local races it replaces, it may be concluded that, as a result of Mr. Hector's work, the grain supply of Bengal has already been increased by about seven and a half lakhs of maunds (about 28,000 tons) per annum. In addition to *Indrasail*, six other types have been selected for yield and are now under careful observation. One of them at least promises to equal, if not excel, *Indrasail*.

*Corrrected figure.

Of the *aus* paddies, seed of the selection *Kataktara* was issued to nearly all the districts which grow this variety. It has met with remarkable success. Not only has it proved to be a heavier yielder than the varieties tested against it, but the quality of the rice is much superior to that of ordinary *aus* paddies. Its only drawback is that it is rather late for two-cropped land. But inspite of this it has become very popular among the growers, and a large demand for its seed has arisen. In Eastern Bengal it is cultivated as a broadcast, high land rice, but in the Bankura district in Western Bengal, it was put in as a transplanted rice with the result that not only did it ripen earlier than the other local varieties but also yielded considerably more grain.

Kataktara is one of a group of three or four selected varieties which stand at the head of the *aus* paddies in respect of yield and quality. It is closely followed in yielding power by *Surjamukhi* and, as one or two strains of the latter appear to possess some advantages in the way of straw, it is by no means certain that *Kataktara* may not ultimately be supplanted by *Surjamukhi.*

It is impossible to exaggerate the value of Mr. Hector's work in connection with this important crop, which bids fair to enhance the prosperity of a larger proportion of the people throughout a larger area than could be affected by the improvement of any other single crop.

In **Bihar and Orissa,** the principal lines of work on this crop are the segregation of homogeneous types from the mass of varieties of paddy collected locally with a view to their classification according to period and yield, and the comparison of the principal types with one another and with the best varieties from other provinces as regards yield. *Indrasail* from Bengal and the best yielding types isolated by the Central Provinces department of agriculture are being tested for yield against the local paddies, while single plant selection is also in progress.

In **Madras,** the crop continued to receive considerable attention from different points of view. A large amount of investigation into seasons and methods of planting, irrigation, and manuring has been carried out, and a good deal of work has

been done in connection with the supply of phosphoric acid of which there is a great need in most of the paddy lands in the Presidency.

As the continued use of heavier yielding strains of paddy implies a heavier drain on the soil, it has been found necessary to meet the condition by heavier manuring. Experience has shown that green manure is a valuable means of ameliorating paddy soils, through the various changes it undergoes in the soil, and the problem is being approached simultaneously from the chemical, the bacteriological and the agricultural points of view.

On the botanical side, considerable progress has been made in the study of the inheritance of characters. Some of Mr. Parnell's selections have yielded surprising results. A strain, No. 1303, has been found to be 16 per cent. better on a comparison carried out under the most rigorous conditions, and two "Red Samba" strains, selected and grown in the Tanjore delta at Manganallur, have shown themselves 17·5 per cent. and 15·5 per cent. better than the farm strain, which itself is superior to the ordinary run of the seed used in the delta. Mr. Parnell has also succeeded in shortening the paddy season in Coimbatore by a fortnight to three weeks without loss in yield.

In the **Central Provinces,** *gurmatia* and *parewa*, two of the heavy yielding selected strains of rice, are growing more and more popular with the cultivators, and they now occupy hundreds of thousands of acres in the Chattisgarh and Nagpur divisions. Some of the new varieties of rice, isolated and tested by the provincial Economic Botanist, have been handed over to the Deputy Directors of Agriculture of the Northern and Southern Circles, for trial. The varietal tests carried out on the district farms indicated *gurmatia*, *luchai*, *chinoor*, *chondu* and *samudrasok* to be the best of the lot under trial.

Green-manuring with sann-hemp has invariably added to the profit of rice cultivation, and the method is being demonstrated extensively. Bulky organic manures have been found to be more profitable for rice than concentrated artificials.

Spacing tests carried out with *gurmatia* and *parewa* showed that for the former, single seedlings planted six inches apart

give the highest yield, while two seedlings of the latter, planted nine inches apart, give the best results in these provinces.

An enquiry into the origin of awns in cultivated varieties of rice has shown that the awned character is the result of variation and of crossing. A study of the natural crosses among the wild rices of the provinces, isolated last year, is in progress.

In **Burma,** the problem of rice improvement differs from that in other parts of India in that the crop is mainly grown for export after milling, and the requirements of the mills, rather than those of the local consumer, have to be met. Shape, colour and consistency of the grain are the important characters from the miller's point of view, duration of growth, yield and the like from the cultivator's. The department's work in improving the crop is conducted with all these objects in view and a considerable amount of success has already been achieved. The pure strains *Ngasein* 8, *Ngasein* 10, *Ngachima* and *Letywezin* have held their position of superiority. *Ngasein* 10, as a heavy yielder, is the premier variety and, inspite of the late rains, it gave yield of 3,084 lb. per acre on an area of 22·74 acres. *Kalagai*, an improved strain at Mandalay, was tried at Hopin with success. At Yawnghwe, the local varieties have been examined and three selections made, which are being multiplied for distribution. *Ngasein* 2104 continues a favourite with the cultivators and the area under it is expanding satisfactorily in Kyaukse district. For the trade in parboiled rice outside Rangoon, the best varieties found are *Emata* and *Letywezin*. Sufficient seed of an improved strain of the latter is now available and an organized distribution of it will be commenced in the next season. The demand for the department's pure line seeds was greater than the supply, and the small millers realized that the crops grown from them were worth a premium. Arrangements have been made for the collection of data regarding the water requirements of the paddy crop in Burma, and the results are expected to furnish useful information.

In **Assam,** selection work was continued for the fifth year at the Karimganj farm. Single pure line selections from 56 varieties of *aus* and from 109 varieties of *sail* were grown for comparison. Three of the most promising selections of *aus* and four of *sail* are receiving an exhaustive test against a standard

type in each case, and it may be possible to make a definite selection at the next harvest.

The testing of improved varieties against local ones was continued on a field scale as also the effect of bone-meal and green-manure on the rice crop. *Indrasail* from Bengal and the local *Georgesail* continued to show their superiority to local varieties. Phosphatic manures give profitable results in the long run and green-manuring considerably improves the crop at a small cost, but returns from the former are not immediately apparent and the cultivator is therefore inclined to regard it as unprofitable.

For a closer study of the rice plant and the many intricate problems associated with it, the **Bombay** Department of Agriculture has started a regular rice research station at Karjat in the Kolaba district where the work of the Plant-breeding Expert on the development and selection of new and improved strains of rice is in progress. It is expected that suitable high-yielding strains will be obtained from the *Kolumba* rice of the locality.

In **Mysore,** the experiments were concerned with varieties, the effects of various manures and artificial fertilizers, the seed rate and the duty of water. Ammonium sulphate with superphosphate gave the highest yield, while cyanamide was a close second. The use of cyanamide, whatever scope it may have, must, however, of necessity be regulated by the cost at which it can be made available to the cultivator. The local varieties have again done better than imported ones.

Wheat. The total area under this crop fell from 35,487,000 acres* in 1917-18 to 23,764,000 acres in the year under report on account of unfavourable weather conditions, and the yield was 7,502,000 tons against 9,922,000 tons* in the preceding year. In spite of adverse conditions, the average yield per acre was higher by 81 lb. than that of the year 1917-18. The total export of wheat amounted to 476,100 tons, valued at Rs. 6,75 lakhs, against 1,454,400 tons, valued at Rs. 19,00 lakhs, in the preceding year. Besides, wheat flour valued at Rs. 81 lakhs was exported during the year as against Rs. 151 lakhs in 1917-18. If the prices of the preceding year had prevailed,

*Corrected figures.

the value of the year's export of wheat and wheat flour would have been Rs. 6,84 lakhs, or in other words, there was an increase of Rs. 72 lakhs in the value due to higher prices. The total imports of Australian wheat amounted to 166,900 tons during the period March to May 1919.

The work of the department in connection with this important crop consists not only in the evolution, trial and distribution of strains of superior yielding power, quality of grain and strength of straw, but also in bringing about intensive cultivation and the isolation of rust resisting types. Many new centres for the cultivation of Pusa 4 and Pusa 12 have arisen, and, as the increased value of the crop is at least fifteen rupees an acre, their cultivation is rapidly spreading. The area under these two types during the season 1918-19 was not less than half a million acres. It is very interesting to note that in some foreign countries also, these wheats are now coming into cultivation. In New South Wales they regularly take prizes at the Royal Agricultural Show at Sydney and last year figured in the official account of the exhibits of the Easter Show.

The cross-breeding experiments of the Howards have now reached an important stage. Many new forms have been fixed at Pusa which are characterized by strong straw, rust resistance, good standing power and heavy yield. They are now being tested on a field scale and are yielding very promising results. One of them, $NH_{98} \times P_4$, gave, on an area of one-tenth of an acre in Gurdaspur (Punjab), the remarkable yield of 45 maunds per acre.

Now that the supplanting of country varieties by improved ones has reached a stage at which further progress should be practically automatic, an increasing amount of attention is being paid to the question of intensive cultivation. Experiments have shown that the superior varieties readily respond to improved soil conditions and generously repay better treatment. To quote a few instances, at Shahjahanpur in the United Provinces, Pusa 12 yielded 36·5 maunds to the acre, after sugarcane, in a year which was not particularly favourable. At Indore, Pusa 4 gave a yield of 35 maunds per acre; while at Mangal-

garh in Bihar it gave, under estate conditions, a record yield of 40¾ maunds per acre.

The results of the Howards' experiments on the water requirements of the wheat crop, which have been in progress since 1912, have been summed up in the second edition of Quetta Bulletin No. 4. They show that by improved methods of cultivation a good crop of wheat can be obtained on a single irrigation following clover. Similar experiments conducted at Gangapur, Haripur and Sargodha in the Punjab and at Mirpurkhas in Sind showed that, after the second irrigation, water ceased to be a limiting factor and began to depress the yield. Mr. Clarke also has obtained quite striking results at Shahjahanpur with one irrigation only on a soil the texture of which has been improved and the surface properly graded.

In the **United Provinces,** the systematic introduction of Pusa 4, Pusa 12 and Cawnpore 13 wheats was continued, and 40,000 maunds of seeds of these varieties were sold in addition to those distributed by zemindars from the seed farms on their estates. In some parts Pusa 12 and Pusa 4 have practically ousted *deshi* wheats, and in other suitable tracts their cultivation is rapidly extending. They are now spreading on their own merits and the work of popularizing them is practically over. Many villages are largely independent of departmental supplies except to maintain purity of the types. However, there yet remains a wide margin between the average outturn of these varieties on the cultivator's fields and the standard regularly attained at the farms of the department. Demonstration is accordingly given of the increased yields obtainable with proper tillage and manuring. By the use of these means a private farm got a yield of 32 maunds per acre this year as against the average of 11 maunds per acre of *deshi* wheats. These types of wheat are however not suitable for the submontane districts, for which new wheats are being tried.

Some new hybrid wheats from Pusa are being tested at Kalianpur and Cawnpore farms. A series of experiments designed to elucidate the effect of varying amounts of irrigation water and different systems of tillage on the yield and quality of wheat are also in progress.

In the **Punjab,** Pusa 12 is preferred for well irrigated areas, while Punjab 11, a type separated by the Howards at Lyallpur from a local mixture in 1906, is especially liked for canal irrigated tracts where the area under it has risen to 302,500 acres during the year from 196,500 acres in the season 1917-18 and 97,000 acres in the season 1916-17. Assuming roughly that Punjab 11 gives one maund per acre more than the mixed varieties it has replaced, the 1918-19 colony crop was at least 3 lakhs of maunds more than it would have been without the distribution of the pure type.

Another type, Punjab 8 A, a selection of Milne, is also being sought after by cultivators and is spreading in some places without the department's help. In test plots at different stations, it has again proved its superiority over Punjab 11 in yield, rust resistance and standing powers. It is bearded and has moderately hard amber grains which do not shred easily when ripe, but being a heavier cropper, it is slightly more inclined to bend over just at the ripening time. In preliminary milling tests also, it is reported to have given better results than Punjab 11 or Pusa 12. However, it has still got to prove its superiority in the field over the latter before its extended cultivation can be pushed on with confidence.

On a ten-acre field at the agricultural farm at **Peshawar,** the Australian wheat named "Federation" has given an average yield of nearly 40 maunds of grain per acre, and in one acre, which was irrigated only once after the seed was sown, 40 maunds 29 seers or fully 53 bushels were reaped. It is the popular "champion-yielding" white wheat of Australia and was first tried in India on the Lyallpur farm; but there it failed to show its superiority over other varieties. On Peshawar farm, however, it has continued to give very encouraging results, having yielded in recent years an average of 35 maunds per acre in the seed areas and experimental trials. As the variety has now shown a still better outturn on field scale on fairly heavy soils, it is hoped that it will succeed equally well on cultivator's fields.

In Upper **Sind,** Pusa 12 is fast gaining in popularity, largely because it ripens earlier than the local wheat. Punjab 11 also shows great promise in Sind where it has proved hardy

enough to thrive on a poor soil, provided three or four waterings are given to the standing crop. Another advantage of it is that, being awned, it is not subject to attack by birds.

Of the varieties of wheat under trial on the Tharsa and Raipur farms, in the **Central Provinces,** AO 89, a selection from *muria*, obtained lately from the Economic Botanist, topped the list for outturn in all the series in which it was tested, and was followed by Pusa 12 and Pusa 100. The manures tried for irrigated wheat added both to the outturn and net profit to the extent of over Rs. 28 per acre. Of the eight different varieties tested on the Sindewahi farm, Pusa 12 gave an outturn of 1,100 lb. per acre while Pusa 100 came next to it. Irrigated wheat would thus appear to do remarkably well in the heavy, clayey soil of this district, though it is not commonly grown at present.

On the Powarkhera farm, AO 13 has given the best outturn and is being propagated for distribution by private seed farms, *deshi pissi* stands second and *deshi jalalia* third. Of the crosses under trial, A 112 and A 113 proved to be superior to the others and are apparently rust-proof.

In **Burma,** wheat is chiefly confined to the Northern Circle. Macaroni wheat is grown at Padu, Nagu and Mandalay, while bread wheat is grown at Hopin, Yawnghwe and Hsum Hsai. Mr. Thompstone has succeeded in eliminating three useful strains of the former with a rise of 13 per cent. on the average yield of the local varieties, and two of these have been put out for multiplication.

Seventeen selections of bread wheat are under observation and some promising strains are likely to result. Pusa 4, Pusa 6, and "Federation" were all grown and gave yields of 1,320, 1,620 and 1,680 lb. per acre, respectively, which are much above the average yield of 450 lb. of local varieties. The main progress has, however, been in the method of cultivation which shows that wheat, after green-manuring, or as a second crop after potatoes where the land has been manured, gives double the crop usually obtained by the Shans.

In **Central India,** the wheats grown are mostly of the black-awned, *pissi* and *durum* (Macaroni) types, which are well suited to dry conditions. As bread wheats, the former two are

the heaviest yielders of the local varieties, while the *ekdania* variety of *durum*, although not a heavy yielder, is probably the best of Macaroni wheats in India in quality. Unfortunately they are seldom grown pure and the obvious problem at present is to obtain pure strains of these varieties and to evolve better ones suited to the conditions prevailing in Central India. As regards varieties suitable for cultivation under irrigation, preliminary trials have indicated the superiority of Pusa 4 and Pusa 12. They have not only proved to be heavier yielders but are of superior quality, and do not require more than three waterings.

Cotton. The yield of the crop of 1918-19 is estimated at 3,671,000 bales (of 400 lb. each) on an area of 20,497,000 acres as compared with 4,065,000 bales* on an area of 25,298,000 acres* of the preceding year, a decrease of 10 per cent. in the outturn. The average yield of (ginned) cotton per acre was, however, higher by 8 lb. The quantity of raw cotton exported during the year was only 183,950 tons or 1,030,100 bales, the lowest figure during the last eighteen years. This represents a decrease of 50 per cent. in quantity as compared with the preceding year. The value of raw cotton exported was Rs. 31 crores and that of cotton manufactures Rs. 14 crores, while the combined value was 19 per cent. below that of the year 1917-18 although Rs. 14,95 lakhs was obtained solely by the higher prices prevailing in the year.

Bombay heads the list of the cotton-growing provinces with an area of 5,851,000 acres under the crop, and is followed by the Central Provinces, Madras, Hyderabad State, the Punjab, the Central India States and the United Provinces.

There are two crops of cotton grown in India, namely, the early and the late. Early cotton grows principally in central and northern India, and late cotton largely in southern and western India. The problems relating to the two crops therefore differ to some extent on account of the difference of the two seasons. For any definite improvement in the quality of cotton in central and northern India, we have mainly to look to the comparatively stable area, *viz.*, that sown on irrigation

*Corrected figures.

before the rains. Adequate marketing arrangements to ensure the cultivator the full value of the improved staple are also essential factors in the spread of cultivation. The efforts of the department towards improvement of the crop are directed mainly to selection and hybridization with a view to obtain the better quality of lint required by the trade, without impairing the yield and the hardiness of the plant or the ginning quality of the *kapas*.

In **Bombay,** the department has now got several strains of high yielding and high ginning cotton of staple above the average for cultivation under conditions best suited to them. For the Bombay Karnatak tract, Dharwar No. 1, originally a selection from the erect plants of *kumpta* cotton (*Gossypium herbaceum*), in spite of some "neppiness" and want of silkiness, has proved to be an excellent cotton both from the point of view of the cultivator and of the trade. It has already spread over large areas and has a great future before it. Its characters are being maintained by fresh selections from protected and self-fertilized plants every year. Two other promising strains—an improved Dharwar-American and a pure selected Cambodia cotton—have also been put out.

In Khandesh and the adjoining tracts, the department's energy has been mainly devoted to the maintenance and extension of *Neglectum roseum* cotton which has grown exceedingly popular all over the tract. The department is, however, trying to get a strain which shall combine higher quality with the high yield and ginning percentage of the *Neglectum roseum* cotton.

In lower Gujarat—Surat and Broach—the original *broach* staple, one of the best in India, was swamped to an alarming extent by other types with higher ginning percentage but of much inferior quality—especially the *ghogari* type. The trade has, however, been co-operating with the department to retrieve the situation, and the following extract from the Director's report will give an idea of the measures taken :—

"A committee of the trade and the agricultural department has been formed in Surat, and the pure improved seed has been now distributed in five groups of villages to the extent of about 6,000 acres. This has been made possible by the special appointment by Government of a cotton superintendent and assistants to distribute seed, examine the

fields at every stage, and finally to supervise the harvesting and ginning. The trade committee's co-operation will be essential when the sale of the *kapas* and its ginning comes on. By the means now in use, we hope to have pure selected seed for 60,000 to 70,000 acres in hand next year. In the meantime, selection is being continued and Mr. M. L. Patil, who is in charge of the work, hopes to have a selection better than that now in use, to distribute on a small scale in the Surat area either in 1920 or in 1921."

In **Sind,** comparative tests of Old Triumph and Punjab 4, two of the selected varieties of American cotton, were made on a fairly large scale on the Mirpurkhas seed farm, and the latter was found to yield better than the former. It also showed remarkable resistance to red leaf blight to which Old Triumph fell an easy prey. Work with the isolation of superior strains from *deshi* cotton has sufficiently advanced to enable comparative tests of four principal types being made on a field scale in the next season.

In **Madras,** work on cotton continued on the agricultural stations at Nandyal, Hagari and Koilpatti on the same lines as in previous years, *viz.*, the careful selection of individual plants in the field, their minute examination and valuation, the determination of the best and their subsequent trial and comparison in decreasing numbers (inferior ones being discarded) and on increasing areas until a point of decision as to whether the cotton can be put out by the departmental organization is reached. The work so far done by the department has met with eminently successful results. Work on "Northerns" and "Westerns" is now concentrated on the two selected strains, Nandyal 14 and Hagari 25. These two strains were grown on seed farms as extensively as possible. A start was also made in multiplying the department's selected stock of Cambodia, and some 3,000 lb. of seed from the central farm was sown in the district by contract growers. A site for a new farm has been selected some 12 miles south of Nandyal where *Sorghum* in rotation with cotton will be tried. Another site for a new station near Anamalai, in the south of Coimbatore district, has been acquired for the Cambodia cotton, but in this connection the Director reports that "the work has been and even now is hampered by lack of time on the part of the Deputy Director of Agriculture and shortage of staff." The department's selec-

tions, Company Nos. 2 and 3, are growing in popularity. *Pulichai*, a low grade cotton, is no longer a problem of any importance: only one small area was reported and was promptly dealt with. This inferior cotton is now practically extinct in the Tinnevelly tract.

In the **Punjab,** practically all the American cotton grown now consists of the department's selection 4F which, at a low estimate, is worth Rs. 18 per acre more than the local kinds. It is getting more and more popular with the cultivator and is rapidly extending. The area under this variety is estimated at 511,000 acres during the year against 390,000 acres last year, and the increase in the cultivators' profit on account of the selection amounts to a large sum. Of the *deshi* cottons, *Mollisoni* retains the lead, followed closely by *roseum*. The white-flowered *neglectum* Bhatla selection also did well, wherever grown.

Work on the evolution of better varieties of cotton is progressing satisfactorily, and it is hoped that the department will soon be in a position to put out one or two improved varieties for trial by cultivators. In experimental tests, several of the selections under trial have given better results than 4F in point of yield and quality of lint. For instance, selection No. 285 F, which on suitable soils yielded seed cotton of 21 maunds 10 seers per acre with a ginning percentage of 32, was reported by the trade as " far better than American middling and good for spinning 50's ", and was valued at Rs. 850 per *candy* (784 lb.) when Sind-American and Cambodia cottons were selling at Rs. 625 and Rs. 650 per *candy*. It is now attracting the attention of farmers and, on account of its high cropping and lint quality, is likely to compete with 4F in the field. In similar tests with the *deshi* selections, *roseum* No. 132 gave the highest outturn of *kapas*.

Conformably to past experience, American cottons have not done well again in sandy soils. Thus, in spite of the favourable season, Americans 285 and 286 F averaged 11 maunds 25 seers and 11 maunds 22 seers of seed cotton, respectively, in sandy soils, against *roseum* 124 which yielded 15 maunds 13 seers. These results indicate the need for caution in recommending American cottons in tracts which are distinctly sandy.

The value of line sowing and interculture for cotton has now been confirmed, and it is estimated that 12,000 acres on the Lower Bari Doab Canal and 6,000 acres on the Lower Chenab Canal were sown in this manner last spring. The possibility of using less water on cotton and the effect of ridging in saving water, especially in September and October, were demonstrated, but the paucity of staff limited the scope of these important lines of work.

In the **United Provinces,** the season was very unfavourable and afforded another illustration of the extreme precariousness of the crop sown on the rains, comprising ordinarily about two-thirds of the whole cotton area. On account of this uncertainty of the crop, the cultivators do not, in spite of high prices of cotton, take much interest in its improvement, and have a natural preference for the hardiest types and for the cheapest possible methods of cultivation. Of the types put out by the department for the rains crop, the Aligarh white-flowered, a selection from the *deshi*, commended itself strongly to the cultivator as a hardy, heavy-yielding cotton with a higher ginning percentage than the ordinary *deshi*. The staple, however, was poor, and as the demand for the lint declined with the cessation of trade with the continent where it was chiefly used, distribution of its seed by the department was discontinued. The Bundelkhand selection, J. N. 1, again yielded well, and all the pure seed available was sown for multiplication. A spinning and weaving trial showed that it was extremely suitable to Cawnpore requirements. It was reported to be superior to the best Kulpahar and Kalpi cottons and 18's warps and 20's wefts were successfully spun and woven. This cotton is now being introduced in the Jalaun district and is also being tested for suitability elsewhere. K. 22, a hybridized cotton produced by Mr. Leake, gave better results on experimental plots than in previous years. Some new varieties of it are being tested for purity and tried on a larger scale. Of these, the re-selection, K. 22/40, grown under irrigation on the Cawnpore, Hardoi and Etawah farms, as well as on about 581 acres in Etawah district, gave good yields.

The type put out for early sowings is Mr. Burt's selection known as the Cawnpore-American. It is so far confined to the

Cawnpore and surrounding districts but the area increased from 1,600 acres in 1917 to 4,700 acres in 1918, and to 9,000 acres in 1919. An account of the experiments in the improvement of this cotton and of field trials during 1913-1917 has recently been published as Bulletin No. 88 of the Agricultural Research Institute, Pusa. These experiments and field trials have proved that, when sown sufficiently early with irrigation, Cawnpore-American cotton is in no way inferior in average yield to *deshi* cotton sown under similarly favourable conditions, whereas it fetches a much better price than *deshi* cotton and is profitable to the grower. The crop as originally grown was mixed in character, but a set of pure-line selections superior to the unselected field crop in yield, ginning percentage and uniformity of staple, has been obtained. One of these, Ca 9, which is agriculturally best suited to the conditions of these provinces, has been sown over an area of 400 acres this season.

It will appear from the above that steps are being taken in these provinces to establish three types of improved cotton, but their extension must of necessity depend on the extra price which the trade is willing to pay for improved cottons.

Of the cottons under trial in the **Central Provinces,** Sindewahi cross gave the best yield in the rice tract of these provinces. The highest yield obtained on *bhata* land (Chandkhuri farm) was from Cambodia which, in some plots, gave a net profit of over Rs. 100 per acre.

The improvement of Chanda cold season *jari* cotton and other *deshi* cottons by crossing and selection is in progress. A trial of different selected strains of Cambodia cotton has also been started.

In **Burma,** work on cotton consists of straight selections from existing varieties for ginning percentage and yield, crosses between different types for improvement in staple, and trials with exotic varieties. The progress with selections has passed the experimental stage and seed of selected varieties is being distributed to cultivators. *Pwinbyu*, a white-flowered early Burmese cotton, occupies about 1,500 acres in Meiktila, Myingyan and Pakokku districts this year. The *kapas* was sold at a premium of Rs. 10 and the cultivators were prepared

to pay a corresponding premium for the seed. A few samples of cotton from selected Shan × *wagale* and broach × *wagyi* crosses, sent to Messrs. Tata and Sons, Bombay, for evaluation, were favourably reported on. The results so far obtained with these crosses are of good promise. The white-flowered *wagale*, *arvensis* No. 4, was grown on eight acres and yielded 419 lb. *kapas* per acre with a ginning improvement of 5 to 6 per cent. The exotic "Utopia" gave a yield of 570 lb. *kapas* at Padu. The staple is long and fine, and the ginning percentage is about 40. A good harvest of Cambodia cotton was made by a cultivator in Allanmyo where the yield obtained was at the rate of 300 *viss* per acre on 25 acres, although it gave disappointing results at Tatkon. Apparently it promises to do well on a certain class of soil and should receive further trials.

In **Bengal,** on the recommendation of the Provincial Agricultural Association, the Local Government, as a special measure, financed a scheme for free distribution of cotton seed. A supply of Dharwar-American cotton seed was obtained from Bombay and distributed to cultivators. In this connection, we quote the following from the Director's report:—

"A few general remarks regarding cotton cultivation in Bengal may be of use to those who are interested in the matter. In the first place, cotton, as a field crop in the plains of Bengal, is practically, at the present time, not in existence. It may therefore be regarded as a new crop whose cultivation it may be desirable to introduce. In these circumstances the first point to settle is whether the crop will grow, and the answer to this would be in the affirmative. The next point for consideration is as to whether there is room for it in the local rotation of crops, and if it would pay the cultivator better than the crops it would replace. Now, cotton is a high land crop, and in Eastern and Northern Bengal, it would replace either *aus* paddy or jute. *Aus* paddy is, however, a food crop and has, in the opinion of many, already been replaced by jute to a greater extent than is economically safe. Moreover, jute is a much more valuable crop than cotton, and therefore it does not appear that there is any place for cotton as a field crop in Eastern or Northern Bengal. As a garden crop, room might be found for a few trees, but this, however worthy of encouragement, could not be expected to furnish more than a small portion of the annual cloth requirements of a family.

"The case is rather different in parts of Western Bengal and in the Burdwan division in particular. On the high lands in this tract there

is practically no jute, and it would appear that there may be an opening for cotton here—a certain amount of it is indeed already being grown. The Agricultural Department has distributed cotton-seed on the same lines as other crops, and the cultivator in Western Bengal is thus provided with the opportunity of comparing cotton, on its merits, with other crops of the tract."

An extensive trial of mixed Cawnpore-American cotton seed, in response to insistent demands for cotton seed for sowing in 1918, showed that this type of cotton grows fairly well in South **Bihar,** and there is no reason to believe that selection will not result in considerable improvement. The selected strains obtained from Cawnpore have done very well on good land at Ranchi, and work on this line as well as comparative trials of the yields are in progress.

In **Central India,** the long staple cotton usually grown in the Malwa tract, known as *malvense* (pure *malvi*), is reported to be so hopelessly mixed with inferior coarse varieties that it is now difficult, if not impossible, to isolate a pure strain of it that will breed true to type. The department has no economic botanist on its staff to take this task up, and it has therefore concentrated its efforts on trials with several varieties of American cotton and Mr. Leake's selection K. 22. Of the former, an Upland Georgian variety called *marwari* and an Indo-Chinese variety called Cambodia have given the greatest promise. On irrigated lands in cultivators' fields in the States of Ratlam and Dhar, they have yielded 1,200 to 1,800 lb. of *kapas.* Owing to their high yielding power and to the fact that the quality of lint is superior to that of the local cotton, their cultivation should spread in areas suitable to their growth. As regards K. 22, it has given promising results on the dry area in many of the States, and, if further trials prove its superiority over the indigenous type, its introduction will be pushed by the department. Manurial experiments carried on with this variety of cotton show that the application of oil-cake, cattle manure, sulphate of ammonia and nitrate of soda, whether applied singly or in combination, yields handsome profits.

In **Mysore,** nine types of cotton isolated last year were sown on the Babbur farm. Those that have come true to type have been further selected and their yields and ginning percentages

have been worked out. Attention is also being paid to the selection of plants showing resistance to "blight." Further work will continue on 94 new selections. Forbes' red-eye cotton has split into three main types, *viz.*, (1) types having flowers with a red-eye, (2) types having flowers with no eyes, and (3) types having flowers of intermediate characters. Hybridization work has been started and many crosses have been made. A study of the pollen grains of the types of cotton in the State has also been planned.

Of the exotics introduced into the State, Cambodia did the best in point of yield, but Lonestar, though not a heavy yielder, showed a higher lint percentage. Selected cottons are under trial in important cotton tracts on ryots' fields and the department is trying to secure the co-operation of the various Agricultural and Cotton Growers' Associations in this work. In the opinion of the Mysore Spinning and Manufacturing Co., Ltd., to whom 11 samples of cottons were sent for examination by the Director, Hagari 25 was the best, having very white and soft lint with a staple one inch long, and Babbur selection 67 of Sonnahatti came next, having a three-fourth inch staple, white but coarser than Hagari.

Sugarcane. The total area reported under this crop during the year was 2,820,000 acres against 2,809,000 acres* in 1917-18. Rainfall was deficient and the yield per acre generally below normal, while in parts of the United Provinces, the Punjab and Bombay a considerable portion of the crop was, owing to the scarcity of fodder, fed to cattle. The total estimated yield, 2,337,000 tons, was thus 29 per cent. below the figure (3,311,000 tons*) of the preceding year. A very large quantity (506,700 tons) of sugar, excluding molasses and confectionery, valued at Rs. 15,37 lakhs, was imported during the year against a small export trade valued at Rs. 48,50 thousands.

Formerly India was in a position to produce a surplus of sugar for export and till recently she was the foremost cane sugar producer in the world, but since the war, Cuba has outstripped her. Although she still has nearly half the world's acreage under sugarcane, her normal output is only a fourth of

*Corrected figures.

the world's cane sugar supply. She is consequently unable to meet her own requirements and has to import large quantities of sugar at what are now enormously high prices. As the beet sugar industry has been disorganized over extensive areas in Europe and as present prices of sugar afford an additional stimulus to sugar production, the opportunity has been taken by the Government of India to investigate the possibilities of reorganizing and developing the sugar industry of the country. They have accordingly appointed a strong committee of officials and non-officials, including two experts from England, under the presidency of Mr. J. Mackenna, C.I.E., I.C.S., Agricultural Adviser to the Government of India, to advise whether a definite and co-ordinated line of policy can be laid down for the promotion of further development. The committee assembled in October 1919, and is now investigating the conditions prevailing in the different provinces. Apart from the appointment of the Indian Sugar Committee, the Government of India have placed Mr. Wynne Sayer of the Indian Agricultural Service on special duty to undertake the collection and co-ordination of all available information regarding the industry as the first step towards the formation of the Sugar Bureau recommended by the Board of Agriculture in India, in December 1917.

As regards work done on the improvement of the crop, that of Dr. Barber at the Cane-breeding Station at Coimbatore, which is proceeding on lines already indicated in previous reports, is the most important from the botanical point of view. The season was a bad one for arrowing, and a disaster was apprehended, but the staff took full advantage of the few flowers, worked along direct and useful lines and thus succeeded in saving the situation. The total number of seedlings raised was 10,800, of which 4,000 of the types likely to be useful in Northern India were planted out. There are now at the station 370 thin seedlings and 180 thick ones, in different stages of selection. Some of the types are proving very resistant to red rot and smut, two of the most serious diseases of sugarcane. The Coimbatore seedlings grown in Northern India were, on examination, found to display wide variation, though, on the whole, they were most promising. The examination has shown the parentage likely to produce canes suitable for the different

localities, and, in the light of this experience, a further lot of seven seedlings has been put out.

Continual improvements are being made in the technique of the work. The results of Dr. Barber's studies in Indian sugarcanes have been published (*Memoirs of the Department of Agriculture in India, Botanical Series*, Vol. X, Nos. 2 and 3), while a preliminary note on the behaviour in Northern India of the first batch of sugarcane seedlings raised at the Cane-breeding Station at Coimbatore is in the press.

In **Madras,** the trial of a number of different varieties of canes forms part of the programme of work at many of the department's farms. Old varieties are losing favour with the cultivator and are being fast replaced by new and improved varieties supplied by the department. This distribution runs to fairly big figures on the East Coast.

The experience so far obtained at the Palur agricultural station shows that the Red Mauritius sugarcane, taken by itself, yields better than local *Namdhari* canes, but does not mill so well as other equally good varieties on account of the hard rind it possesses. Fiji B and B. 208 stand high manuring without the disqualification of lodging, possess better milling qualities, yield a heavy outturn per acre and remain matured or fit for milling for a longer time than other varieties tried. B. 1529 and J. 247 are heavy yielders and mature a month or 40 days earlier than others; and B. 147 matures at the same time as Red Mauritius but excels the latter in yield and milling quality. The ryots of South Arcot who dispose of their canes to the Nellikuppam factories are recommended by the department to grow all these varieties in order that they may be able to dispose of their crop by instalments at leisure. Even where they deal with the crop in local mills and pans, an extended period for cutting the cane and manufacturing the *jaggery* is a decided advantage.

The work on improved methods of *jaggery*-making initiated at Cumbum last year was successfully extended. It comprised a practical demonstration of the fact that the proper construction of the furnace and the consequent better combustion of the fuel used make it possible to do away with the necessity of pur-

chasing any fuel, the megass and trash from the cane itself being sufficient. It has also been shown that in addition to the saving in the cost of fuel, the *jaggery* manufactured on improved lines fetches from Rs. 4 to Rs. 7 more according to quality for a *puttie* of 500 lb. By the adoption of these improved methods, the ryot can easily secure an extra profit of Rs. 80 to Rs. 100 per acre of sugarcane grown, and there is no doubt that he will take full advantage of the improvement.

In the **United Provinces,** the work of testing the new varieties and improving the cultivation of sugarcane was continued at the Shahjahanpur cane farm. Three new varieties of canes raised from cuttings imported direct to Shahjahanpur were given out to circle farms for trial and did remarkably well on large areas in the Eastern Circle. Twenty-two seedlings from the Sugarcane-breeding Station at Coimbatore have been successfully raised and will be grown on a field scale next year.

Experience with imported canes shows the necessity of constant renewal of stock from the country of origin. An effort to overcome this difficulty by the Java system of growing for seed in the hills, has so far given encouraging results. With regard to the suitability of imported canes, the Director reports as follows :—

"The effect of different soils and climatic conditions on the canes is very marked. Among *deshi* canes certain varieties have established a definite superiority in particular tracts, but fall off greatly in quality if transferred elsewhere; as, for instance, *Hemja* in Gorakhpur, *Reora* in Benares and *Dikchan* in Rohilkhand. It would now appear that a similar local differentiation is required with imported canes, and selections will have to be made to suit particular areas. This greatly increases the amount of experimental work and renders experience gained in one part of the cane-growing tract of doubtful value for another. It may possibly call for the establishment of a new research station."

The question of improved cultivation has greater importance in these provinces than the introduction of new varieties, and particular efforts are being made to demonstrate widely the value of better methods. An illustrated bulletin dealing with the subject is under issue.

Mr. Hulme, the Sugar Engineer, has designed a special type of mill which promises to prove stronger and more suitable for

village conditions and to give a higher expression than the mills now in use. It will receive a fair trial in the next season.

Owing to the failure of the cane crop, the Nawabganj Sugar-Factory could not be supplied with more than 8,000 maunds of cane some of which was extremely poor. It was therefore decided to make the bulk into *gur*, and the transactions left only a small margin of profit. The factory will probably have to be removed to some other tract; but for another year it will be kept at Nawabganj to clear off advances.

In **Bengal,** considerable progress has been made with the survey of local varieties, some of which, for instance, *Hemja*, a medium thick russet cane, and *Marikul*, a purple cane, both of tall vigorous growth, showed decided promise and gave juice containing 15·5 per cent. and 15·2 per cent., respectively, of sucrose. Unfortunately, the multiplication of none of the local canes has proceeded sufficiently far to enable a *gur*-making test to be made which, it is hoped, will take place in the next season. Of the exotics, J. 247, a Java cane sent for trial by Dr. Barber, gave the best results and yielded 60 maunds of *gur* per acre. Yellow *Tanna*, which is another good yielder and also hard enough to be jackal proof, is popular amongst cultivators.

It has finally been decided that the long contemplated sugarcane station for North **Bihar** should be located at Sipaya. Work on buildings, etc., has been commenced and it is hoped that the station will be in working order next year. Meanwhile, 90 varieties of sugarcane, including 29 sent by Dr. Barber, have been planted at Sipaya, and the sugarcane expert, when appointed, will therefore find immediate scope for work. Thirty-four of the varieties isolated by the late Mr. Woodhouse at Sabour have been grown in pure culture.

A large number of the best yielding canes imported into India are also under trial at Ranchi and Cuttack.

In **Assam,** the work on this crop comprises the testing of varieties under chemical control, manurial experiments in the cane rotation, trials of various methods of planting, the distribution of the best varieties to cultivators and cultivation by steam tackle on a factory scale. White Mauritius, a sport of

Striped Mauritius, did best with a yield of 29·5 tons of cane per acre and high sugar content. J. 33A, Barbados A, and B. 3412, although heavy yielders, proved comparatively poor in sugar content but, in view of its hardness and high yielding qualities, J. 33A appears to have a chance of proving a suitable variety for small cultivators. A proper rotation has been found to increase the yield by 5 tons of cane per acre, while manuring with phosphates has given, in the case of plant canes, an average increase of about three tons per acre against a decrease of about two tons per acre in the case of ratoons, which is accounted for by a severe attack of disease on the treated area last season. A number of new varieties were grown in the nurseries for propagation and preliminary trials: of these, several show promise, notably Purple Mauritius, D. 74 and C. 6 and 9.

On the Kamrup farm, where cultivation of cane was carried out on a factory scale, 239 acres were under plant cane and 230 acres under ratoons of the 1918 crop of plant cane. The season was again unfavourable for the crop and the ratoons were poor owing to the delay in cutting the cane in the previous year. The crop amounted to about 5,000 tons, of which, owing to defects in the machinery, the mills could not take more than 1,855 tons and the remainder had to be thrown away. The plant cane varied from 26·3 tons per acre on land which had been reclaimed a year in advance to about 9 tons on land which was broken up during the year. This confirms the previous experience that in order to get good results land should be broken up at least a year before planting. The mill-owner has since transferred his interests in the plantation to a company, and a leading Calcutta firm has obtained settlement of a neighbouring tract of land for the cultivation of sugarcane. This at least shows that the experiment is not without promise.

In the varietal tests, *Sannabilla*, *Red Pundia* and *Khari* gave the largest yields on the Tharsa farm in the **Central Provinces,** while on Sindewahi farm *Khari* and *Yuba* surpassed all other varieties both in yield and acreage profit.

Java 247, *Yuba* and *Khari* again did well on Adhartal farm. *Khari* has proved to be a good variety for ratooning and is fast replacing the poor *Katai* canes formerly grown in the north of

the provinces. Gilman's Red also gave big outturns, but it is doubtful whether there is much scope for extending the cultivation of thick soft canes in this tract where the standard of cultivation is low and where soft varieties are so apt to be damaged by pigs. The *Khari* variety of cane, although known to be most susceptible to smut elsewhere, shows peculiar resistance to the disease in the Central Provinces.

The analysis of sugarcane grown on the Tharsa experimental farm showed that some of the seedling canes obtained from the Cane-breeding Station at Coimbatore were of excellent quality, and ripened early.

The improved furnace designed by Mr. McGlashan has been tested on the Sindewahi farm for the last two years, and has proved to be cheaper and more economical than the Poona type. The improved furnace will be recommended for general adoption by cane growers this year.

In **Burma,** high prices of sugar and *jaggery* are stimulating the extension of the area under sugarcane. The main cane-producing area lies in the Southern Circle around Bilin and between Pyu and Pyinmana, but cane cultivation is being taken up in parts of the Northern Circle also, for instance, at Hopin, Nagu, Singaing and Yawnghwe. At Hopin, very good yields of *jaggery*, from 2 to 3 tons per acre, were obtained. The Union at Thawatti has now 100 acres under the crop, and near Tatkon cultivation has started in sixteen new centres. Of the exotics at Singaing, the variety known as Gilman is very promising. Twelve exotic varieties at Hmawbi have been multiplied and sets of six of them have been sent for trial on a plantation at Nyaungchidauk where they are reported to be flourishing.

Certain improvements in boiling pans and crushing mills are being adopted.

In **Bombay,** the work on sugarcane during the year has been small as the famine obliged the department to devote a large part of its principal centre (Manjri farm) to the growth of fodder crops. Manurial studies, irrigation investigations, trials of methods of cultivation and the testing of varieties were, however, continued. Economical methods of cultivation and manuring devised in the farm have led to a saving of expendi-

ture of about Rs. 100 per acre, and the methods now worked out for green-manuring cane with sann-hemp promise to lead to a further saving in the cost of production.

At Saval-vihir farm, the Java method of planting cane with a minimum amount of water promises to be very successful, especially on land likely to be water-logged. In Konkan, where the principal work has been to find the most suitable varieties and to ascertain the extent to which they will profitably bear high manuring, Striped Mauritius cane has so far yielded the best result. On the Sukkur farm (Sind) also, this variety of cane successfully stood comparative tests made with some of the other varieties and was found suitable for *gur*-making.

In the **Punjab,** no further work has been done on this subject in the year, except chemical control of the manurial and varietal experiments at the Gurdaspur experimental station. Of the varieties tried, *Behar* and *Yuba* with 3,656 and 2,872 lb. of *gur*, respectively, stood first and second. A power-driven cane-crusher by the American Plow Company has just been installed and a new boiler for cane juice is being erected by the Agricultural Engineer.

In **Mysore,** Red Mauritius has shown itself capable of giving heavy yields under varying conditions and its cultivation is being actively encouraged. Last season it yielded 392 maunds of *jaggery* per acre against 365 maunds given by J. 33A, 322 maunds by *Cheni*, 240 maunds by *Pattapatti* and 214 maunds by other Java canes. It also yields nearly double the amount of fuel when compared with the local *Pattapatti*. The manurial tests with Red Mauritius indicate that even at present times the application of oil-cake, at the rate of 3 tons per acre, yields a net additional profit of about Rs. 375. J. 33A, which is also a heavy yielder, tillers well and does not lodge easily and so deserves a good trial in place of *Cheni* in tracts where that variety is grown at present. Planting of canes in rows not closer than three feet apart gave the best results. One hundred and nine types of seedling canes from Hebbal were tried on Babbur farm, and 26 types which have proved better than the local *Rastali* have been planted, with Red Mauritius as a check, along with 82 other new varieties sent from Hebbal. A few of

the best seedlings, found superior to Red Mauritius in yield and vigour, are being tried on private estates.

The high price of imported sugar has stimulated the local manufacture of sugar in several places by the old method. Improved methods have been suggested by the department and it is arranging to put up an improved furnace.

In **Central India,** the crop is at present grown on a very limited area, but the soil is suited to the growth of heavy crops of cane, provided adequate arrangements are made for irrigation. Of the introduced varieties of cane, Ashy Mauritius has shown the greatest promise. Java 33 also did very well until it developed the smut disease. Ashy Mauritius is reported to have yielded 25 to 46 tons of cane per acre at Indore and Dhar. As regards manufacture of sugar, the Agricultural Adviser to States in Central India remarks :—

"*Gur* is the class of sugar made locally, which, owing to the high purity of the juice, is of excellent quality. I do not advise altering the product or encouraging the making of white sugar, for the price of *gur* in Central India is at a figure which ordinarily will be more remunerative than sugar, but I recommend merely improving the existing crude methods of extraction and marketing the commodity in a more attractive form, such as in small moulded blocks. The use of small mills, driven by oil-engines, would also be a great advantage."

Experiments with varieties of sugarcanes have been in progress on the **Pusa** farm since 1905, and they indicate that of thin canes, *Hemja, Bhurli, Mungo, Reora* and *Saretha,* when treated with rape cake at one ton per acre and irrigated twice before the rains, are capable of giving yields approximating to 20 tons per acre. Among medium varieties, J. 33, J. 36, J. 213 and J. 247 give good yields but are deficient in drought-resisting quality. *Yuba* gives over 25 tons per acre when grown on the double-mould-board plough method and manured with sann-hemp, nitrate of soda and superphosphate. Dr. Barbar's seedlings, Co. 201 and Co. 202, are drought and disease-resisting varieties as well as heavy yielders approximating to over 30 tons per acre. Among thick canes, Red Mauritius and *Sathi* No. 15, do best, but not better than the thin canes, with equal treatment; while in years of drought and high winds, they suffer more. They are also more susceptible to red-rot disease, but

comparatively immune to smut. So far, therefore, the experiments show that, with proper manuring and irrigation, the yields of thin and medium varieties, which from all points of view appear more suitable than the thick ones, can be increased by over 50 per cent. One ton of rape cake applied in two doses or farmyard manure in quantity sufficient to give the same amount (about 100 lb.) of nitrogen tends to increase the yield considerably. Green-manuring with superphosphate is also found very beneficial, while crops of poor, stunted growth begin to flourish after treatment with 30 lb. nitrate of soda per acre. Two or three irrigations, that is, once a month before the break of the monsoon, benefit the crop considerably.

Jute and other Fibres. The area under jute fell from 2,736,000 acres* in 1917-18 to 2,500,400 acres in the year under report, and the yield from 8,864,600 bales* to 6,955,600 bales of 400 lb. each. The value of raw and manufactured jute exported out of India during the year was Rs. 65 crores, the highest on record. This represented 27 per cent. of the total value of the exports of Indian merchandise as compared with 21 per cent. in 1917-18. Figures for other fibre crops are not available as they are not separately collected at present.

The conditions created by the war have necessitated a thorough investigation of the fibre resources of India. At present, India, and especially Bengal, enjoys a practical monopoly of the world's supplies of jute. In profit to the cultivator and manufacturer, it is doubtful whether any other crop in India can successfuly compete with jute, production being far short of the demand. There is, therefore, strong ground for advocating the extension of the cultivation of jute to other suitable localities, and a thorough investigation of the possibilities of growing more extensively other fibre plants also such as sann-hemp, *Hibiscus cannabinus*, *Sida Rhombifolia*, sisal hemp, flax, etc. Work on the improvement of fibre plants (other than cotton), which is in the hands of Mr. R. S. Finlow, has, up to the present, been practically limited to Bengal and Assam. The scope of this work has now been extended to other provinces also, but his appointment to officiate as Director of Agriculture,

*Corrected figures.

Bengal, has prevented Mr. Finlow from entering upon this wider field of enquiry as yet.

Jute continued to be the chief item in the programme of the work of Mr. Finlow. It was stated in last year's report that there appeared to be a considerable variation in the resisting power to *chlorosis* on the part of various races of jute. Two of the races continued to show the same immunity to this disease as they did last year. It would thus seem that immunity of plants to disease is hereditary in character. Non-chlorotic strains were almost invariably found to be more vigorous and taller than strains subject to *chlorosis*. In variety tests, one non-chlorotic selection (R. 85), a strain of Kakya Bombai (*C. capsularis*), yielded a much better crop than other strains of the race which were chlorotic, *viz.*, $2\frac{1}{2}$ maunds more fibre per acre. About 35 tons of seed of R. 85 will be distributed in the coming season. The work is especially important as there appears to be a considerable danger of the spread of the disease.

Kakya Bombai continued to grow in popularity and the demand for its seed far outstripped the supply. About 55 tons of seed of this variety were distributed in the province in small quantities of $\frac{1}{4}$ lb., for multiplication by the ryots themselves who are beginning to realize the necessity of growing their own seed of new varieties, especially because of the impossibility of getting seed supplied in bulk by the department. District reports speak of the excellent prices obtained by growers of this new variety, and the premiums obtained for it on account of its quality are probably due to its late flowering habit. The advantages of this habit were fully discussed in last year's report where it was stated that the general adoption of late flowering varieties would tend to improve the quality and yield of jute. This view is now practically confirmed. The area under Kakya Bombai is increasing in the jute tract of North Bhagalpur where about 200 maunds of seed were sold and the demand far exceeded the supply.

Kakya Bombai is not, however, the last word in jute selection. One or two other selections of Mr. Finlow promise to rival, if not to beat, Kakya Bombai. Hitherto none has done so excepting the non-chlorotic strain of Kakya Bombai, R. 85, referred to above.

In variety tests with pure lines of *C. olitorius*, R. 26 kept its place at the head of the previously tested races, while a new race (Chinsura green), included for the first time in the test, did extraordinarily well. About 5 tons of the seed of R. 26 were raised during the year for sale and distribution.

Manurial trials on the red soils have yielded more striking results in the year under review and have finally proved that, for jute, lime and potash are both limiting factors and that a normal crop cannot be grown on the red soil without the application of manures containing both of them. The results also serve incidentally to establish the value of hyacinth ash as a potash manure. The money expended on lime, bone and potash manures practically trebled the net revenue per acre, and in doing so yielded interest at approximately 100 per cent. per annum. The results are now considered well established and arrangements are being made to demonstrate them to cultivators.

With a view to ascertain how far the nature of the fibre of the jute plant is affected by details of cultivation, such as the amount of thinning which the crop undergoes, and what the effects of environment are on the quality of jute fibre, arrangements have been made to carry out important series of experiments at the *mufassal* agencies of certain jute firms. The experiments, if successful, will be of great value both to the agricultural department and to the jute trade in general, as they will answer the question why the different tracts are recognized by the trade as producing characteristic fibre.

In Assam, Kakya Bombai was again tested at the Karimgunj farm against one of the heaviest cropping local varieties and it continued to show its superiority. There is now a growing demand for this improved variety in both valleys and arrangements have been made to provide a large supply of seed for next year. A manurial test with bene-meal, ground limestone, hyacinth ash and cattle manure, applied singly and in combination, showed in each case a profitable increase in outturn of fibre.

In Bihar, jute was grown mainly for the supply of seed to Bengal.

Trials with jute were continued at several farms and other places, including jail gardens, in Lower Burma. In Upper Burma, it was grown at Hopin and Nagu with success. On the high garden land of Yedashe farm a yield of as much as 1,100 lb. of clean fibre was obtained, but yields at other places and in jail gardens were not so encouraging. Further trials are being made in the Irrawaddy delta, but the growing of jute in this province appears to be a doubtful business proposition on account of the small advantage of profit in its cultivation over that of paddy and the difficulties and expensiveness of labour in Burma.

Sann-hemp. The provinces producing sann-hemp on a large scale are Bengal, Bihar, the United Provinces, the Punjab and the Central Provinces, but the crop is grown all over India, either for fibre or as a fodder plant. The fibre from Bengal and the plateau districts of the Central Provinces has the best reputation in the market. Some of the provinces, however, for instance, the Central Provinces, the United Provinces and the Punjab, experience difficulty in the matter of retting water. An artificial process of extraction would not only largely obviate this difficulty but would effect an undoubted gain in nitrogen to the soil; for the amount of nitrogen recovered through avoiding the present wasteful retting process might be as much as 40 lb. per acre, and would open the possibility of green-manuring without loss of a revenue crop. With the aid of a special grant, Mr. Finlow is working in the direction of improving the method of extraction of sann-hemp and much will depend on his success in solving the problem. Meanwhile, it is gratifying to note that he has succeeded in elaborating a softening process which promises to render sann-hemp fibre fit for use in the textile industries, *e.g.*, for the manufacture of canvas.

Sida. Experiments with *sida* have been carried on for some years, and a straight-growing plant has now been obtained by Mr. Finlow. The cultivation of *sida* and the extraction of its fibre are similar in all respects to that of jute, the chief difference being that *sida* can be sown later than either jute or *Hibiscus cannabinus.* Its great advantage over jute, for tracts

in which the climatic conditions of Bengal do not obtain, is that, when sown on high land at the beginning of the monsoon, it yields a good crop of about 15 maunds per acre of excellent fibre which fetches 20 per cent. more than the market rate for first class jute. Trials with *sida* as field crop at Dacca have again given excellent results.

Hibiscus cannabinus. The improved type known as Pusa 3 is doing well in some foreign countries as well as in India. The preliminary trials given to it by the agricultural department of the Union of South Africa proved satisfactory and that department asked for a large quantity of its seed. At Nagu in Burma it gave a yield of 700 lb. per acre.

Sisal hemp. This is now produced only in small quantities grown on an experimental scale. At Mandalay, from a plot planted out in 1911, it gave a yield of dry fibre of 840 lb. per acre. An enterprising cultivator is laying out a small plantation under the advice of the agricultural department near Sedaw.

Indigo. The season was not favourable for the crop and the total area under it fell to 300,700 acres which was 58 per cent. less than that of the preceding year. The falling off in the area was particularly heavy in the United Provinces, Madras and the Punjab, and was apparently influenced by the heavy drop in the price of the dye and the difficulty experienced in disposing of the produce in the market. The estimated yield of dye was 44,100 cwt. which was less than the figure (126,800 cwt.) of the year 1917-18 by 65 per cent. The exports (32,700 cwt.) were 5 per cent. above those of the preceding year and 112 per cent. above the pre-war average. The increased production of artificial dyes in the United Kingdom again reduced her demand for the natural product from 5,500 cwt. to 4,700 cwt. There was, however, a noticeable increase in the exports to Japan—14,300 cwt. in 1918-19, as against 2,800 cwt. in the preceding year and 400 cwt. the pre-war average. The average declared value decreased from Rs. 492 per cwt. in 1917-18 to Rs. 382 per cwt. in 1918-19.

The problems relating to the industry are under investigation from several points of view. For results of studies on the

chemical, bacteriological and manufacturing sides, reference should be made to pages 62 and 81-83. Investigations on the agricultural and the botanical sides only are referred to here.

On the botanical side, the Howards continued the study of the conditions necessary for the growth and seed formation of Java indigo, of the factors of importance in its root development and of the principles underlying its improvement by selection. One of the difficulties encountered in the cultivation of Java indigo in Bihar is a condition known as wilt. After the middle of the monsoon, the plant often ceases to thrive and extensive destruction of fine roots and nodules is found to occur. With a view to determine whether there is any relation between water-logging from below and the appearance of wilt, a series of lysimeter experiments was carried out. These experiments showed that the indigo in the lysimeters with free drainage escaped wilt.

For the fifth year in succession, the continuous Java indigo plot in the botanical area at Pusa yielded a fine crop of seed. A good crop was also obtained on a field lent by the Dholi estate. In connection with these field results, the effect on growth and seed formation of alterations in the soil texture by the addition of such aerating materials as sand, broken tiles and leaf-mould, or a combination of these substances, was further investigated, and it was found that the substitution of 40 per cent. of the volume of the soil by leaf-mould (30 per cent.) and potsherds (10 per cent.) increased the production of seed about twenty-one times. Another interesting feature noted was the cessation of growth in length in all cases at the beginning of December, irrespective of the soil conditions or of the size of the plants. It, therefore, follows that, to obtain good crops of seed, large plants must be produced by the end of November and practically all the seed must have set by that time.

At the request of the Bihar Planters' Association, it has been decided to undertake an investigation into the possibility of increasing the indican content of the indigo plant by selection, which appears to be essential if natural indigo is to compete successfully in the open market with the synthetic product, and the post of a whole-time botanist has recently been sanctioned.

In the Central Provinces, indigo did well on *bhata* land. It has now been definitely proved that on such land indigo can be carried over the hot weather without irrigation.

Tobacco. The most important tobacco tracts in British India are: the Coimbatore, the Dindigal and the Godavari Delta tracts of Madras, the Rangpur tract of Bengal, the Bihar districts of Bihar and Orissa, Gujarat in Bombay and the delta tract of Burma. Although in recent years there has been a conspicuous increase in the number of cigarette factories in India, the value of the total imports of cigarettes and other tobacco rose from Rs. 1,69,97,000 in 1917-18 to Rs. 2,14,61,000 in the year 1918-19. There is, however, also an important export trade, the value of which rose from Rs. 51,01,000 in 1917-18 to Rs. 96,36,000 in 1918-19. The Howards' pure line selection, Pusa type 28, which combines yield and quality, and is suitable both for cigarette making and for general cultivation, continues to do well in Bihar, the United Provinces and in Burma. The demand for seed of this type has been steadily increasing and could not be met in full last year, although indents for about 5,000 acres of new cultivation were dealt with by the Imperial Economic Botanist. An effort will be made this year to grow a larger stock of selected seed. In Bombay, as a result of attempts to introduce exotics, a superior hybrid variety has been obtained which is fast ousting the local varieties. In Burma, an experiment in rack-curing of Pusa type 28 was conducted and about one ton of cured tobacco was supplied to a Rangoon firm for trial on the home market. The result of the trial is not yet known, but as the local dealers valued the cured tobacco at Rs. 85 per 100 *viss* as against Rs. 60 for local varieties, there can be no doubt as to its superior quality. The quality of Burma tobacco is at present low; and there is great scope for improvement here. Superior varieties such as Havana and Pusa type 28 are now being introduced by the department.

In Bengal, the Burirhat farm (Rangpur) is devoted mainly to tobacco where trials of Sumatra, American and Turkish varieties, and experiments on the improvement of local varieties by selection and on the manurial requirements of the crop are in progress. Great improvement in Sumatra tobacco has been effected by using seeds raised from carefully selected

plants. An average outturn of 1,017·6 lb. per acre has been obtained and the quality has been accepted by the market as highly superior. The ryots are taking up the cultivation of this tobacco very largely. The American varieties tried did not prove suitable; but the Turkish varieties made good cigarettes. The quality of Burirhat cigars has been much improved and the demand for them has consequently increased. The value of green-manuring with cow-pea has been thoroughly established.

With regard to the effect of different manures on the quality of tobacco, the experiments conducted by Mr. J. N. Mukherjee, First Assistant to the Imperial Agricultural Chemist, showed that, except in respect of the chlorine content, the analytical results bore no relation to the manurial treatment of the plant. Tobacco manured with saltpetre, was found to burn well but quickly, while the burning value of that manured with superphosphate was much inferior. A combination of these manures produced a tobacco which burnt fairly well and not too quickly.

Oil-seeds. There was a slight increase in the exports of oil-seeds during the year over those of the preceding year. The total value of these exports was Rs. 11,21,84 thousands as against Rs. 8,22,19 thousands in 1917-18.

Linseed. This crop is grown mainly in the United Provinces, the Central Provinces, Bengal, Bihar and Orissa, the Punjab and Bombay. The total area under linseed was 1,973,000 acres, which is 48 per cent. below the final figure of the preceding year. The prolonged drought not only restricted the area sown but also adversely affected the growth of the crop almost everywhere. The total estimated yield of 229,000 tons was below that of the preceding year by 56 per cent.

Sesamum. The area under the crop during the year was 3,501,000 acres, against 4,279,000 acres* in the preceding year. The season was unfavourable. The estimated yield was 258,000 tons as against 381,000 tons* in 1917-18, a decrease of 32 per cent.

This crop received special attention in Burma where some $1\frac{1}{4}$ million acres are under it. Its importance there lies in the fact that the edible oil appeals most to the Burman palate. The

*Corrected figures.

varieties of sesamum grown in the province were collected and kept under observation. Selection has now been narrowed down, and tests are being carried on to ascertain the respective merits of eight selected strains. Yield tests among the most promising varieties gave results which indicate that a heavy cropper in a normal season may be outclassed by a less promising strain in a season of light rains. The results of experiments on drill-sowing and broad-casting as practised in the province, indicated the superiority of the former by an increase of over 20 per cent. in the yield. An interesting paper on the Burmese sesamum varieties, by Mr. A. McKerral, has been published in the " Journal of the Asiatic Society of Bengal," October 1918.

Groundnut. The great intrinsic value of groundnuts and the fact that they grow well on poor land with the cheapest of manuring make them one of the most promising crops for experiments.

In this connection it may be noted that the results[1] of the experiments conducted by Captain R. L. Mackenzie Wallis on the food value of the groundnut show that excellent flour containing a large amount of protein, certain amino-acids in quantity, mineral salts, and fat can be prepared out of it at a reasonably small cost. This should prove an excellent substitute for the German foodstuff sold under the trade name of " nutrose," and it is hoped that the preparation of groundnut flour will develop into a profitable industry in due course.

In Bihar and Orissa, a large mass of material arising from natural crosses found at Ranchi is being segregated into types, with the object of getting a late type with a stiff, upright stem which will stand a long monsoon, when sown in April and May, without succumbing to fungus diseases. Meanwhile, several selections made from the crop originally imported from Raipur, which show a considerable resistance to disease in a normal year, have been grown on a field scale and will be tested for yield.

Of the several varieties grown in the United Provinces, Barbados gave the highest yield (28 mds. 20 srs.), Dharwar was next (34 mds. 25 srs.) and was followed by Egyptian groundnuts

[1] *The Indian Journal of Medical Research*, Vol. VI, No. 1, July 1918.

(33 mds. 25 srs.). They gave the best yield when sown some two feet apart.

In Burma, several varieties were tested, but the upright small-seeded types, such as Tumbu, small Japanese and Spanish, were found to be more profitable to grow and more easy to harvest than the spreading Burmese types now grown. The cultivation of these varieties is being encouraged and 206 baskets of Spanish and small Japanese nuts have been issued by the department as a nucleus for multiplication and distribution.

On *bhata* land in Chandkhuri in the Central Provinces, groundnut yielded about 316 lb. per acre without manure.

In Mysore, five types of groundnuts were tested. Local *Sogatur* gave the highest yield. Barbados and Carolina, two of the most promising varieties, are being multiplied for distribution.

In Central India, Spanish pea-nut and small Japanese gave satisfactory results in yield, quality and early maturing habits. Yields from 258 lb. to 1,000 lb. per acre, valued at Rs. 30 to Rs. 120, have been obtained.

Coconuts. Considerable progress is reported by Mr. Sampson in his work on coconut cultivation at the new stations on the West Coast.

There are many suitable areas in Burma for coconut plantations, and it has been proposed to have a survey made of the Arakan coast for the purpose of indicating areas where such plantations are likely to thrive. There is an unlimited market for the oil and by-products.

Castor. Owing to the great demand which has arisen for castor oil as a lubricant, the classification of *kharif* and *rabi* castors grown in the Central Provinces has been begun with the object of isolating and propagating promising types. With a view to encouraging a more extensive cultivation of castor, the department supplied 57,396 lb. of seed to cultivators. The crop did well and high rates have been paid for the seed. In the United Provinces also, 403 maunds of seed were distributed to the cultivators.

In Mysore, 42 selections and 43 types were tested. Five of the best selections are being multiplied for distribution.

Tea and Coffee. The provinces where tea is grown are Assam, Bengal, Madras, the United Provinces, the Punjab, Bihar and Orissa, Burma and the State of Travancore. The total area under tea during the year was 678,500 acres, against 667,100 acres* in the preceding year. The total production of manufactured tea (black and green) was 380,459,000 lb. as against 371,296,300 lb.* in the last year. The average production of tea varies greatly in the different districts. The highest production in the year was in Lakhimpur (Assam), *viz.*, 751 lb. per acre, and the lowest in Garhwal (United Provinces), *viz.*, 38. lb. The average production in the whole of India was 609 lb. per acre plucked, or 3 lb. per acre more than in the preceding year. The exports were 324 million lb., valued at Rs. 17,77 lakhs, an increase of Rs. 10 lakhs over the previous year.

The Indian Tea Association continued to maintain a scientific department for the investigation of all problems connected with this crop in North-East India with the help of the usual grant-in-aid from Government. It is proposed to expand the staff of the department by the addition of a botanist and a bacteriologist. The Association continued the publication of a quarterly journal and also issued a "Memorandum on the use of artificial manures on the tea estates in Assam and Bengal," in addition to certain other publications relating to tea diseases and pests. In Southern India, the crop receives special attention from the Deputy Director of Agriculture for the planting districts. A good deal of work has been done there during the year on the prevention of soil erosion. Terracing with buried prunings and keeping a crop of some selected weed, not necessarily leguminous, always on the ground have checked wash. These methods have been followed on an estate scale in many places with excellent results. It has been decided to start a tea experiment station on Stagbrook estate in Peermade. The "Planters' Chronicle," a weekly paper issued by the United Planters' Association of Southern India, meets the needs of the tea planting community in that part. The tea experiments in the Kachin Hills in Burma promise success. The tea produced there makes an excellent blend with China tea.

*Corrected figures.

The chief coffee-growing areas are Madras Presidency, Mysore, Coorg, Travancore and Cochin. The total exports of coffee rose during the year to 219,000 cwt., valued at Rs. 1,19,38 thousands, as against 196,000 cwt., valued at Rs. 99,31 thousands during the preceding year. By hybridization followed by selection, a type of *arabica* coffee possessing a value far above that of the ordinary strain of coffee grown in South India has now been fixed. This new hybrid possesses unusual vigour, is fertile, comes true to seed, bears early and heavily, and resists disease. It is now being tried on an estate scale and, so far, the result has been astonishingly good. Twenty acres planted at Malishwar on the Malambi Range, Somwarpet, at the age of two years, is giving a crop of about 7 cwt. per acre, while individual trees are bearing still more heavily. A site for a coffee experiment station has been selected near Sidapur in Coorg. The station will be started shortly.

For work done on diseases and pests of tea and coffee reference should be made to pages 68 and 73.

Rubber. The exports of rubber during the year were 125,000 cwt., as against 75,000 cwt. in the preceding year. The value of the exports rose from Rs. 1,62,19,000 in 1917-18 to Rs. 2,50,31,000 during the year under report. The area under rubber has increased in Burma by 2,957 acres to a total of 66,524 acres.

In Southern India, rubber manurial experiments were continued at Kerali. A spacing experiment was also started there with the object of discovering the best and most economical distance at which rubber should be planted. It has been decided to open a Rubber Experiment Station at Mooply valley in Cochin and another at Tenmalai in South Travancore. Sites have been selected for the proposed stations and the preliminary work is in progress. For work in connection with rubber diseases a reference may be made to page 69.

Fruit. Fairly extensive work on fruit crops has been undertaken by the Bombay Department of Agriculture. It comprises methods of cultivation, propagation, manuring and dealing with diseases of mangoes, *Citrus* fruits, guavas, papayas, figs, and grapes. Progress on such a subject must of necessity be slow

and it is only rarely that it is possible to convert a dying industry to a flourishing one in a few years. This has, however, been achieved in the case of the grape-growing industry of Nasik and Ahmednagar as a result of the introduction of spraying against the grape-vine mildew by the agricultural department.

In the Punjab, the date-palm cultivations at Taleri Bagh, Muzaffargarh, give promise of success. Arabian dates of the Halawi and Khudrawi varieties have proved excellent. A book entitled "The Date-Palm and its cultivation in the Punjab" has been published by Mr. Milne.

In the Central Provinces, manurial and irrigational experiments with oranges are being carried out on the Tharsa and Adhartal farms and by the Economic Botanist at Nagpur. No definite conclusions have yet been reached, but the results so far obtained indicate that for orange trees artificial manures are of little value. Of the bulky manures, *mahua* refuse would appear to be one of the best. Different varieties of pine-apple are being tested on the Chandkhuri farm and are doing well.

Fruit culture receives considerable attention on the demonstration farm attached to St. Andrew's Colonial Homes, Kalimpong (Darjeeling), from which cuttings, graftings, etc., are supplied free to cultivators in the district. Various kinds of fruit trees, Indian, English, Japanese and Australian, are under trial. The Agricultural Department of Bengal contributes Rs. 5,000 per annum towards the upkeep of the farm.

The results of the fruit experiment station at Shillong (Assam) are very promising. Good fruit, including numerous varieties of apples and pears, has been produced. Arrangements are being made to have grafts supplied from the station for use in the Khasi and Jaintia Hills. It is proposed to establish a few small orchards of non-tropical fruits at selected centres in the upper ranges of the Khasi Hills, and five sites have been selected for the purpose. At Sadiya, a start has been made with *litchi*, guava, peach, orange, lime and pomelo trees with the object of distributing grafts in the future. In the Naga Hills the orchards are reported to be doing well. Guavas, almonds and Japanese oranges did excellently in the garden at Tessima.

The fruit experiment station at Quetta continues to do valuable work under the Imperial Economic Botanists. The improved fruit boxes devised by them continue to prove satisfactory in use and have added considerably to the scope of the trade in fruits grown in Quetta and Chaman. The boxes are sold for Rs. 5-8-0 each, are returnable free of charge from all stations in India and can be used many times. The dealers have now realized that it pays to put money into better packing, and to adopt a system which reduces damage in transit to a minimum.

Fodder Crops and Grasses. In Bombay, fodder crops have had special interest paid to them during the year on account of the acute famine conditions which prevailed during the year. Most of the work consisted of growing as large crops as possible to meet the occasion. Excellent results were obtained with some of the crops—for instance, at Surat, no less than 49,000 lb. of green *jowar* fodder per acre were obtained in two crops, and at Manjri farm equally good results were obtained with maize. Of the new fodder crops tried, *marvel* grass (*Andropogon annalatus*) proved to be suitable for Western India and *para* grass (*Panicum muticum*) for water-logged tracts. The elephant grass (*Pennisetum purpureum*), imported from South Africa, also proved to be a heavy yielder. *Shevri* (*Sesbania ægyptiaca*), a leguminous fodder plant commonly grown in the Deccan, has proved at Manjri to be capable of giving very large yields when cut much lower than it is usually cut.

In Sind, berseem grows very well, especially where water is available, and it is now thoroughly established there. On the Sukkur farm, its average yield has been 43,000 lb. of green fodder per acre in the season. Sown in September, it yields six cuttings by the May following. For the conditions requisite to its success, readers interested on the subject are referred to Bulletin No. 91 (1919) of the Bombay Department of Agriculture.

The extension of the use of silos has been seriously taken up. Experiments have proved that splendid silage can be made in the Deccan and that, if properly made, 65 per cent. of the original green weight can be taken out after four or five months.

A pattern of silo that will suit the conditions of the cultivator is under demonstration, and it is gratifying to note that the Trustees of the Sassoon David Fund have come forward with a grant of Rs. 5,000 in aid of this work.

A new fodder crop, namely, the bamboo (*D. strictus*) was added to the list of those under trial on the Chandkhuri farm in the Central Provinces. This variety produced a luxuriant growth of green foliage which was fed to, and greedily eaten by, cattle. It seems very probable that this species can be grown successfully for fodder on *bhata* land. Seedlings of this variety planted at the beginning of the rains establish themselves without irrigation and, after three years, yield about 20 tons of green fodder per acre against 1½ tons of spear grass which is the natural fodder produced by this soil at present. The leaves contain from 4 to 5 times as much protein and twice as much oil as are contained in the common grasses of the provinces.

In Burma, guinea grass (*Panicum maximum*) has continued to flourish at Hmawbi and Mandalay, and is in considerable demand by rubber planters.

In Assam, *kheri* cane, guinea grass and Rhodes grass yielded 14·1 tons, 23·5 tons and 14·2 tons of green fodder per acre, respectively, at Jorhat. Rhodes grass which is much finer than guinea grass has shown much promise as a cold weather fodder crop. At Upper Shillong, *raishan* is grown for hay, and maize and Job's Tears for silage. They make excellent fodder for cattle.

Miscellaneous. *Jowar* (*Sorghum*). Of the *jowars* under trial in the Central Provinces, *Ramkhel* and *Saoner* again gave the highest yield. Artificial crosses were made between various *jowars* with the object of studying their unit characters on Mendelian lines.

In Madras, Mr. Hilson has evolved a strain which is 33 per cent. superior to its next rival, and has beaten the local unselected Sorghum, seven times out of eight.

A few types of *jowar*, selected at the Aligarh farm in the United Provinces, were sown for comparison; *Dodania* proved to be the heaviest yielder and was closely followed by *Andhari*. They also proved to be the best for green fodder.

Potatoes. The Bombay Department of Agriculture has succeeded in developing a pedigree strain of potato seed free from the ring disease. This proved of greatest importance as importation of fresh seed from Italy has ceased since 1915. A system of manurial treatment of potatoes, devised by the department, has been found to increase the yield cent per cent. in a number of cultivators' fields.

Scotch potatoes continue to do well in the Simla Hills. Experiments with potato storage are in progress at Sialkot.

For sometime past, hill potatoes, which are of considerable commercial importance in the United Provinces, have been showing signs of deterioration. Steps to improve them by distribution of fresh seed are being taken up by the department.

In Burma, potatoes are chiefly grown in the Northern and Southern Shan States and the Bhamo district. Experiments have shown that drill-planting and the application of unburned manure give heavier yield than the methods in practice now. There is much room for expansion of the crop in the province.

In Assam, 23 varieties of potatoes were under test on the Upper Shillong farm; " King of Potatoes," " Magnum Bonum," " Windsor Castle " and " Imperator " gave the heaviest yields. There is a great demand for seed potatoes both from the hills and plains districts, and to meet the demand it is proposed to issue farm-grown seeds to Khasi cultivators on condition that they keep the seed pure and return from the crop one and a half times as much as the seed supplied. The average advantage of the Shillong varieties of potatoes over the *deshi* varieties was 2,225 lb. per acre in Kamrup, 2,394 lb. in Nowgong and 2,426 lb. in Sibsagar.

Gram. A series of trials of different varieties of gram sent by the Howards from Pusa have yielded promising results in the United Provinces and the trials will be continued on several farms. Considerable quantities of some of these grams (Pusa 17 and 18) have been issued to selected growers with successful results. In a comparative trial at Pusa, types 17 and 18 gave the best yields, *viz.*, 29 maunds 32 seers, and 27 maunds 37 seers, respectively. A fair demand for seed has arisen and

it is likely to increase with the popularity of these types of gram.

Ragi (*Eleusine coracana*). In Madras, Mr. Hilson's No. 8 *ragi* again proved itself undoubtedly superior to all others and marks almost the highest point reached in this work, an increase of 92 per cent.

In Mysore, the advantages of using improved seed of *ragi*, of rotating it with groundnut, of early cultivation with improved ploughs and of green-manuring the late crop have been definitely proved. Interculturing, which by the way can only be practised when the seed has been drilled in, has also been found to have a favourable influence on the yield. The tests with fourteen purified types of *Hain ragies* showed that *Hellubele* gave the best yield and that this type as well as *Maḍḍayangiri* stood drought much better than other types. The types with heavy ear-heads seemed to prefer moist conditions and did well under irrigation. Two pedigree strains—(Mg. 1-5) and (D. 1-18-51) also gave very high yields and were multiplied for general distribution. In spite of the trying seasonal conditions of the year, the former gave far heavier yields than the local varieties on the cultivators' fields. Further work on selection is in progress.

Poppy. The investigations on the improvement of the morphine content of opium have been continued at Cawnpore. Mr. Leake's pure line selections of poppy, wherever tried in the fields, kept up their quality and yielded results markedly better than those of the local varieties which gave rather poor opium. One of these selections gave 12 seers 1 chataks opium (rich in morphine) and 5 maunds 26 seers 10 chataks seed per acre on the Partabgarh farm. Some new selections possessing a high yield of morphine are being evolved.

Barley yielded 1,030 lb. of grain per acre at Hopin and, should it prove successful for brewing, will add another profitable crop for Northern Burma and the Shan States.

Beans. In Burma, the area under *Pebyugale*, a small white bean (*Phaseolus lunatus*, Linn.), increased by 80,156 acres over last year's figures although it has lost favour for export purposes on account of the cry of "prussic acid" raised more for

political than for scientific reasons. Another white bean, *pe-nge*, has given promising yields and the prussic acid content is lower than that of *pebyugale*. The area under large white beans (*pegyi*) has also increased by 5,873 acres and the yield by 881 tons, but that under red beans (*pegya*) suffered a decrease of 29 per cent. on last year's area. The growing of beans as a second crop at Tatkon has been adopted by the villagers after seeing the success obtained at the farm. It is estimated that the area now under double-cropping around Tatkon yields in gross produce from the second crop some Rs. 60,000 a year.

In Assam, the Rangoon bean grown on small plots at Jorhat gave very promising results. As it has a high value on the British market, it will be tried on a field scale next season.

The work in progress at Quetta on the *sun-drying of vegetables* has been extended considerably. About 1,500 half-pound tins were prepared and sold chiefly to the engineering parties engaged on the Nushki Extension Railway and the various regiments operating in Mesopotamia and Persia. With a view to increase the production at a smaller cost, power peeling and slicing machines have been installed. These have proved very successful and easy to operate. Exhibits of the products, shown at the Medical Conversazione at Parel and at the Lucknow Flower Show, attracted the attention of a large number of visitors. Altogether eight selling agencies have already been established in India and there appears to be a bright future before the industry. Medical opinion confirms the presence of anti-scorbutic and anti-beri-beri properties in sun dried vegetables.

Experiments on the *drying of bananas* have been carried out by Dr. W. Burns and Mr. P. G. Joshi, and they have arrived at the conclusions that bananas can be dried successfully at places other than Agashi,[1] and that sun heat is sufficient for the purpose. The process of drying adopted by them is very simple. The only precaution required is the protection of the product from dust and insects; and for this purpose it has to be stored in airtight tins or jars, and examined periodically. The results of the experiments will shortly be published as an article in the

[1] "The drying of plantains at Agashi," by L. B. Kulkarni, *Agrl. Journal of India*, Vol. VI, Part III, 1911.

"Agricultural Journal of India." In this connection, it may be mentioned that some experiments on the drying of bananas, recently carried out in Jamaica, showed the superiority of the sun dried product to that artificially dried in a drying apparatus. These results are in favour of the simpler and cheaper method of sun drying which can be easily adopted by our cultivators.

(*b*) Agricultural Chemistry.

The present world crisis due to the conditions arising out of the war has brought into greater prominence the importance of chemical research in connection with agriculture. The world-spread scarcity of foodstuffs and the consequent abnormal rise in their prices demand that more should be produced from the soil. The study of Indian soils and the factors governing crop production has all along been engaging the attention of the agricultural chemists of the department, and the results so far achieved have, in many cases, brought about increased outturns of crops of value. Much, however, has still to be done. The need for the provision of specialized laboratories with separate staffs, under the Imperial Department, for the investigation of problems connected with soil physics, physiological chemistry, soil biology, etc., is being keenly felt, and the recommendations on this subject of the last sectional meeting of chemists and bacteriologists, held at Pusa in February 1919, are under the consideration of the Government of India. At the same meeting, a strong sub-committee was appointed for the purpose of examining methods for the analysis of soils, and a provisional draft of the proposed Fertilizers Act, recommended by the Board of Agriculture in India, 1917, was drawn up for the consideration of Government.

Investigations carried out during the year are reviewed below :—

Soils. In Bengal, considerable progress has been made with the provincial soil survey. The analytical data obtained generally resemble those of the preceding year and are supported by the results of field tests. The incidence of *Rhizoctonia* in jute in the red soil tract as a result of potash starvation, and the attack of other fungus diseases, such as the pigeon-pea wilt,

appear to be associated directly with chemical conditions existing in the soil. It is not, however, possible to draw, at this stage, more definite conclusions without further information.

In Bihar and Orissa, the survey of the Bhagalpur soils has been completed and the Kosi area in the Purnea district has been taken in hand.

Detailed chemical and mechanical analyses of soils from typical orange gardens were carried out in the Central Provinces. It was observed that the soils of the best orange gardens contained a high proportion of lime. A study of the phosphatic requirements of the soils of the provinces is in progress.

The soil survey of the tea districts of the North-East India was carried on by the Scientific Department of the Indian Tea Association.

In Madras, the soil survey of the Kistna has been completed and work on the Godavari survey has begun.

A complete survey of soils growing indigo in different districts is in progress and is expected to furnish data of great importance.

Work on the reclamation of barren land in Montgomery district in the Punjab is in progress. The results indicate no fundamental constitutional difference in composition of abnormal soils when compared with normal cultivated soils situated near by. The colloidal properties of these soils are under investigation. The work in connection with the seepage was confined mainly to the study of the flow of viscous liquids in porous media and the movement of subsoil moisture under field conditions.

In the North-West Frontier Province, an area impregnated with salts, measuring 235 acres and situated near Muhabbatabad in the Mardan sub-division, has been selected for a reclamation experiment, and on the advice of the Imperial Agricultural Chemist it has been decided to try two systems of flooding and drainage, *viz.*, (*i*) carrying off the water by means of deep drains until the land is sufficiently free of salts to be cultivated, and (*ii*) the use of comparatively shallow drains for the same purpose.

Manures. Mr. Warth and Maung Po Shin were engaged in working out the phosphate requirements of Lower Burma paddy soils. The work consisted of soil analyses combined with suitable pot culture tests to show up deficiencies in phosphoric acid. The results obtained[1] by them show that the lack of phosphoric acid is by no means general all over the tract. It is serious only within definite areas, and the available phosphate supplies of the province will therefore meet the want more easily than it was feared might be the case.

The soil nitrogen in these soils is, however, far from readily available, and this seems to be more particularly true of the soils poor in phosphoric acid. The authors conclude that the lack of available nitrogen is so serious that phosphoric acid manuring cannot increase crop yields, but, should the vegetation produced during the early rains be sufficient to act as a green manure, thus making the nitrogen more readily available, phosphoric acid manuring will give immediate crop increase on such soils. The same officers have also studied[2] the absorption of lime by soils from two main points of view, *viz.*, (1) effects of neutral salts on soils, and (2) effects of lime as hydrate, carbonate or bicarbonate on soils. The experiments have given definite information regarding conditions under which lime is removed from or absorbed by soils of different types and have further indicated that the absorption takes place in a similar manner whether it is effected by the organic or the inorganic soil constituents.

The importance of the subject of effective phosphatic manuring led to an investigation of the mode of action of superphosphate in calcareous and non-calcareous soils at Pusa. The general conclusions arising out of the investigation are that the retention of phosphoric acid in calcareous soils is a different phenomenon to that in non-calcareous soils; that the range over which applications of superphosphate are effective is wide in the case of non-calcareous soils but very restricted in the case of calcareous soils; and that the principles underlying its use in non-calcareous soils or soils of low calcium carbonate content are

[1] *Memoirs of the Department of Agriculture in India, Chemical Series*, Vol. V, No. 5.

[2] *Memoirs of the Department of Agriculture in India, Chemical Series*, Vol. V, No. 6.

not equally applicable to calcareous soils. The conditions for effective phosphatic manuring in the latter have, therefore, been subjected to further study.

Field experiments on the effect of manuring with superphosphate and sann-hemp on indigo soils in Bihar, initiated by Mr. Davis, have confirmed the last year's results that superphosphate is of great value in these soils. It not only secures very big increases of the indigo crop, but its use in the case of *rabi* crops also has been found to be very profitable. Some extraordinary increases of *rabi* crops have been reported from Champaran which, even with superphosphate at its present high price, represent net profits of Rs. 60 to Rs. 70 per acre. In one case, the use of superphosphate and sann-hemp is reported to have given a gain of over Rs. 100 per acre at present prices. From these reports it appears probable that many of the soils in Bihar, which now regularly yield very poor crops, can be greatly improved and made to yield good crops by manuring with superphosphate. The results of the experiments are in the press (*Indigo Publication No. 6*).

The experiments started at Pusa with a view to ascertain the action of green manures in relation to paddy and their effect when employed in conjunction with direct manures were continued. The preliminary results point out that the increase in the outturn due to the green-manure tends to increase as the cropping due to nitrogen alone increases, thus giving some confirmation to the conclusions deduced from previous investigations, *viz.*, that they mainly act in an indirect manner. A series of experimental plots have been laid down with the object of determining the comparative values to be ascribed to the direct and indirect action of green manures. The line of work being followed by Mr. Wilsdon in the Punjab, with a view to investigate the relative importance of the nitrogen and humus factors in this cultural operation, indicates that the addition of humus, particularly in the case of light soils, plays a preponderating part in increasing the cropping—probably mainly due to the improved water-retaining power of the soil.

A considerable amount of research work on phosphates has been done by the Agricultural Chemist, Madras. The import-

ance of the work lies in the fact that a crying need for almost all crops in Southern India is phosphoric acid, and that there is an enormous potential store of this material in the Trichinopoly phosphate deposits. This, however, is not in a form "available" for the needs of the plant. Research is therefore devoted to ascertaining how this "availability" can be secured, and the problem is being tackled along bacterial and chemical lines.

The importance of conserving such natural sources of manure as oil-cakes, bones and fish for use in the country was discussed recently by the Board of Agriculture in India which considered it desirable to discourage the exports of such materials.

Sugarcane. The question whether the storing of canes by windrowing in the North-West Frontier Province has any deteriorating effect on juice continued to engage the attention of the Imperial Agricultural Chemist. In order to follow the course of the changes taking place in the cane, numerous tests were made during the period December 1918 to March 1919. The results so far obtained show that the process does not lead to any appreciable decrease in the quality or the amount of sugar obtainable from equal weights of juice of the original and the windrowed cane, but, after a certain time has elapsed, deterioration sets in. The date at which deterioration first occurs is the same for all canes irrespective of the dates of windrowing. As the canes windrowed in December 1917, did not, however, show any sign of deterioration for about double the period during which they maintained condition last season, and as during both the years a falling off in the quality was first noticed immediately after a heavy rainfall, the main factor in bringing about this condition would appear to be a seasonal rather than a biological one. These observations, however, require further confirmation and the experiments on the subject will be continued.

In Madras, Mr. Viswanath has done valuable work on the refractrimetric examination of cane juices, and is engaged in working out the possibility of analysing the juice of canes by this method *without cutting them down*. The method promises to be of great value in any investigation into the ripening or

selection of cane. The results so far obtained have been published in the Special Indian Science Congress Number of the "Agricultural Journal of India," *1919*.

An investigation into the changes taking place in different parts of the cane throughout the ripening period has been taken up by Mr. Meggitt in Assam, and some interesting results have been obtained.

Indigo. Problems on the preservation of indigo in paste form have been solved by the Indigo Research Chemist by sterilization, and the method evolved is being used satisfactorily. Further study of the problems relating to the manufacture of indigo is being done in collaboration with the Imperial Agricultural Bacteriologist and a report on the progress of the work will be published after the next *mahai*. Trials on the preparation of pure indigotin are in progress.

Miscellaneous. The Agricultural Chemist, Madras, has prepared excellent samples of "shredded wheat," "grape nuts," vermicelli and macaroni, and has shown that flours prepared from South Indian leguminous seeds form a good substitute for pea flour. The most important fact that has been brought out is that certain grains, such as *ragi* (*Eleusine coracana*) and *Cholam* (*Sorghum vulgare*) are capable of producing excellent malts which can be used as a basis for preparing infants' and invalids' food. In addition, a good malt extract can be readily prepared from them and used for the production of "malted milk."

Owing to the importance of Burma beans, Mr. Warth devoted a considerable portion of his time to investigation of their hydrocyanide content. The main lines of investigation have been : (1) the selection of better strains, (2) the study of the rôle of hydrocyanide in the plant and (3) the study of the hydrocyanide content and enzyme activities of stored beans. Some interesting results have been obtained, but further work has to be done before any definite statement can be made.

In the United Provinces, Mr. Clarke has started an investigation into the proteins of the important Indian pulse crops some of which have been isolated for the first time in a pure state. Preliminary methods have been worked out for the in-

vestigation of nitrate formation and its variation in Indian soils as affected by methods of cultivation.

The feeding value of all the principal varieties of *jowar* seed was worked out by the Agricultural Chemist, Central Provinces. It was found that the amount of dextrine formed during the baking of *jowar* bread is one of the factors which determine the palatableness of the grain as a foodstuff.

(*c*) Mycology and Plant Pathology.

Plant diseases in India caused by fungus parasites are numerous and destructive, and the losses due to them are at least equal to those recorded in other countries. Our chief cereal—rice—although relatively less liable than other cereals to attacks by parasitic fungi, has of late years been subject to serious outbreaks of *ufra* and "blast" which have caused heavy losses in certain important rice-growing districts. Rust of wheat is as severe in this country as anywhere else in the world; while our troubles with the diseases of other staple cereals, of jute, sugar-cane, cotton, tea, coffee and rubber are by no means slight. Our staff of mycologists is small in comparison to the number of problems being tackled or awaiting investigation, but they can legitimately claim successes in checking the ravages of diseases such as the bud-rot of palmyra palms, *ufra* of rice, smuts of *jowar* (*Andropogon Sorghum*), diseases of fruit trees and grape vines, etc. None of the provinces, except Madras, has got a mycologist, but proposals for appointments in the United Provinces, Central Provinces and Bombay are now under consideration. The Indian Tea Association has its own officer who is engaged in studying the diseases of tea in North-East India, while a mycologist for work in connection with the diseases in planters' crops in South India has recently been added to the cadre of the Madras Department of Agriculture. Another mycologist, for rubber diseases, has been sanctioned and the rubber planters in South India are taxing themselves by a cess which is to be made over to Government for the upkeep of his staff and laboratory equipment. It is proposed to have, for purely mycological work in the South Indian planting districts, two experimental stations for rubber, one for coffee and one for tea. These arrangements will not only ensure

proper attention being paid to the diseases of tea, coffee and rubber, but will enable Mr. McRae to concentrate his attention on the ordinary crops of Madras. Another happy feature of the year was the co-operation of a Bombay business firm—the Union Agency—who were willing to provide a portion of the staff and expense needed for work in connection with the diseases of potato. With their co-operation, fumigation of potatoes was carried out successfully, a pedigree strain of potato seed, free from the ring disease, was developed, the rotting of potatoes in storage was investigated and methods of completely checking the *tambera* disease were worked out. The example is worthy of emulation, and the thanks of the Agricultural Department are due to the Union Agency for their pioneer work.

The sectional meeting of mycological workers in India, held at Pusa in February 1919, called attention to the neglect of mycological science in Indian Universities and emphasized the importance of the subject in India. They urged that the Universities should arrange to give courses and found lectureships or chairs in the subject. It is hoped that the recommendation will improve the facilities for the study of this branch of science.

On the recommendation of the same meeting, the Government of India have agreed to participate in the scheme for the establishment of an Imperial Bureau of Mycology in England and to contribute towards its upkeep a sum of £250 a year for three years. It is believed that this Bureau will be very useful to workers in mycology in India.

The progress of work done during the year is briefly reviewed below :—

Diseases of Paddy. *Ufra.* An account of this important and exceedingly serious disease, which has spread over a wide tract covering several districts in Eastern Bengal, was published as a Memoir by Dr. E. J. Butler, early in 1919. The disease appears towards the end of the rains. The tips of the leaves of plants affected turn brown; afterwards the ear, which is just forming, and then the whole plant dies off. Many plants, however, do not die immediately, but merely look stunted in growth and produce little or no grain. Full details regarding the distribution of the disease so far as at present known, the life-history of the

worm (*Tylenchus angustus*) which causes it and the methods of control that have been found satisfactory are given in the memoir. Recent work on the parasite tends to indicate that its spread is likely to be limited to certain areas of high humidity, and that much of the rice-growing tract of Bengal, where the atmospheric humidity at critical periods is less, is likely to be either unsuitable for its growth and multiplication or suitable for only so short a period of the year that serious damage is not likely to be caused. Further work on the factors which influence the motility of the worm and its persistence under field conditions is in progress. The advantages of following the general recommendations made some time ago with regard to this pest, *viz.*, the burning of the stubble of the previous crop and dealing with the lower-lying areas which remain wet throughout the year, have been confirmed. A certain amount of stubble-burning is now done in the *ufra*-infected areas, and infection is thus reduced to a considerable extent. The full effect of these measures cannot, however, be realized unless all the cultivators in a locality adopt them without exception, and thus destroy the main sources of infection. Unfortunately it is difficult to secure combined action on the part of the cultivators.

The disease known as "blast" caused by *Piricularia Oryzæ*, an account of which was published by Mr. McRae in the "Agricultural Journal of India," Vol. XIV, Part 1, 1919, did not recur on paddy during the year under review in localities where it was very severe last year, although there was an epidemic of "blast" on *Panicum repens*, a grass common on paddy *bunds*. At Coimbatore, it was however found attacking patches or varieties of paddy which showed particularly luxuriant growth, but it did not do much damage. The possibility of its becoming a limiting factor on the production of high-yielding varieties of paddy in Madras makes a thorough investigation of the disease absolutely necessary, and McRae has been giving a good deal of his time to it.

Diseases of Jute. The disease caused by *Diplodia Corchori* and known as "black band" is widespread in Bihar, Eastern Bengal and Assam, and has been engaging the attention of Dr. Shaw, Second Imperial Mycologist. The first symptom of the

disease is the appearance of a black band on the stem ringing the plant. The plant then dries up and is left standing as a black stick. Usually the disease is worst on well grown crops. The facts mentioned in the last report that the late sown crops appear to be relatively free from the attack of *Diplodia Corchori* and that only stems of a certain size and maturity are liable to infection under natural conditions in the field, were abundantly confirmed from inspection of the jute crop in Bihar and Eastern Bengal. The disease was practically absent in the crop of *Corchorus olitorius* and the red-stemmed varieties of *C. capsularis*, but the inoculation experiments in progress do not establish their absolute immunity. The fungus appears to possess a strong cytolytic enzyme capable of destroying the fibrous part of the bark. The results of experiments, although not yet conclusive, do not suggest that the spread of the disease through spores mingled with the seed is an important means of dissemination. Should these results be confirmed by further experiments, it will probably be unnecessary to persist in disinfecting the seed. As a precautionary measure, however, treatment with copper sulphate was carried out this year on some 40 tons of seed grown in Bihar. Fresh experiments have been laid down in collaboration with the Fibre Expert and the results will be awaited with interest.

While working on the last disease, Dr. Shaw met with a number of cases of a jute disease due to infection with the sclerotial fungus previously identified as *Rhizoctonia Solani* and found a new spore form not readily distinguishable from that of immature *D. Corchori*. It occurs only on the jute plant, and investigation as to whether it is a stage in the life-history of *R. Solani* is in progress.

Diseases of Sugarcane. The results so far obtained by Mr. Dastur in his investigation into the mode of infection of the sugarcane smut, *Ustilago Sacchari*, mark a decided advance in our knowledge of this important disease. It has been found that direct infection of thin varieties can take place only in two ways: (1) through the young tender "eyes" and (2) through the older "eyes" when wounded or injured. Thick varieties can only be infected in the latter manner, a fact which accounts for their relative immunity to the disease. Infection does not

appear to take place through the cut ends of setts or through adventitious roots : the dormant " eyes " infected in the autumn, however, develop smut when sown in the following spring. This explains why setts from stools showing no external signs of the disease at the time of planting give a smutted crop.

The most serious disease of sugarcane in India is the " red rot." The results of selection sett by sett, before planting, which has been in practice on the Pusa farm from 1904, show that an epidemic of the disease can be prevented in this manner and the rate of infection can be brought down to 5 to 10 per cent. In Madras, Mr. McRae has succeeded in bringing down the infection on the Coimbatore farm to 1 per cent. by seed selection, stool by stool. This, however, entails a considerable amount of labour, and it seems that, for practical purposes, stool selection once in a while, followed by sett selection annually, would be a better method to adopt.

Dr. Shaw has found two sclerotial diseases of sugarcane at Sindewahi in the Central Provinces, which appear to be identical with the Java diseases called Zuur Rot and Rood Rot. These diseases are, however, of minor importance.

Diseases of Chillies. The study of the diseases of chillies has been continued by Mr. Dastur at Pusa. The chief trouble in Bihar is the " die-back " disease caused by *Vermicularia Capsici* which attacks both stems and fruits. It also causes considerable loss of fruits in Madras and in Bombay. Spraying with Burgundy mixture gave good results in Bihar, but was not equally successful in Madras, possibly on account of the difference in the climatic conditions of the two provinces. Late sown crops are found to be less susceptible to the disease, but give poor yields and are not likely to be commercially successful. Similarly, interculture with *rahar* (*Cajanus indicus*), as a shade crop between the rows of chillies, had the effect of stunting the latter.

The " blossom and twig rot " due to *Choanephora cucurbitarum*, which caused much damage to chilli plants in Bihar in 1917, was not observed last year on a single plant. This disappearance of the disease suggests that it is dependent on humidity, the chief difference between the two seasons being the

abnormal dryness of the latter at the flowering period. Some damage was done by a new disease the cause of which is yet unknown.

Diseases of Pulses and Beans. Dr. Butler, in collaboration with Mr. Finlow, has been investigating the relationship between soil conditions and the incidence of the wilt disease of pigeon-pea caused by *Fusarium udum*. Experiments to test the effect of different plant foods and stimulants have been started at Pusa and will be continued. It will, however, take several years to arrive at definite results. An investigation by Dr. Shaw of the disease of Rangoon beans (*Phaseolus lunatus*), erroneously reported in the press last year as due to *Phytophthora* but in reality due to a *Sclerotinia* or allied fungus, is in progress. It appears that a simple way of checking the disease is to grow the crop in lines two and a half feet apart and thus to allow free circulation of light and air.

Diseases of Tea and Coffee. The work on tea diseases in North-East India was continued by Mr. Tunstall, and experiments to determine the longevity of various leaf fungi, in fallen leaves, twigs, etc., under different conditions, were continued. Further researches on *Exobasidium vexans* were made, and allied species and their host plants were studied. It was found that leaf diseases did not live long in prunings and "grey blight" quickly died of its own accord. A stem disease of tea in Darjeeling, caused by *Nectria cinnabarina*, was cured quite easily by spraying with lime-sulphur solution. Another new disease of tea was the "black rot," caused by a *Hypochnus* allied to, but apparently differing, in some details, from the species which causes the disease in Ceylon. Clearing the jungle and removing excessive shade seem to be all that is necessary for checking it. In South India, the main disease of tea was "brown blight." On account of the difficulty of getting sprayers, spraying was, unfortunately, out of the question, but the attack was successfully kept under control by hand-picking diseased leaves. Pest gangs organized for the purpose were found very useful.

Spraying of coffee with Bordeaux mixture against the leaf disease, caused by *Hemileia vastatrix*, gave good results in Madras. In one trial, 100 acres were sprayed, and the improve-

ment not only in the yield but in the quality of the berry was enormous. The cost was about Rs. 18 per acre.

Diseases of Rubber. The disease of the Para rubber tree (*Hevea brasiliensis*) caused by *Phytophthora Meadii* continued to engage the attention of Mr. McRae. Besides occurring on leaves and causing them to fall, this *Phytophthora* also causes a fruit-rot, a rotting of the bark near the tapping cut, and a partial die-back of the branches. The fungus starts its activity after the dry season at comparatively few points, but with the break of the monsoon it spreads rapidly. Mr. McRae estimates that in South India it causes an annual loss of about £100,000 sterling. Removal of the fruits and affected branches before the break of the monsoon and the destruction of the flowers either by cutting them off or by spraying with a chemical have been found to stop the rapid propagation of the fungus. For the prevention of the bark-rot, the method that has become general is to paint the tapped surface of the bark with a disinfectant —Izal, and a mixture of tar and tallow. Luckily the disease was conspicuously less during the year under review, probably on account of unusual monsoon conditions.

Unfortunately, a new rubber disease has come to light which seems likely to be as serious as any yet experienced. The symptoms resemble a disease known as " brown bast " in other countries in the East, and the effects are a complete cessation of the yield of latex. No causative organism has yet been discovered, but the disease is under the investigation of Mr. McRae. Another disease of rubber dealt with during the year was that known as " pink disease." Various experiments have been carried out for its control. Painting the stems, lower branches and forks of the young trees with Bordeaux mixture in the hot weather gave good results. Treating of alternate rows seemed to reduce the attack on the untreated trees also.

Diseases of Palm Trees. The campaign against the bud-rot of palmyras (*Pythium palmivorum*) in the Godavari and Kistna districts remained under the control of the district officers, the Agricultural Department acting in an advisory capacity. It appears that the disease has been reduced to the lowest mark possible by this method and that there is little

likelihood of any further reduction unless tree owners are compelled to take action themselves.

The season was against the development of "Mahali" disease (*Phytophthora Arecæ*) of areca palms in Madras. Some 10,000 trees were sprayed, the garden owners paying the actual cost of materials used. The annual campaigns against the same disease in the Ratnagiri and Kanara districts of the Bombay Presidency have been continued with great success. The use of the method, which has completely stamped out the disease in some of the Mysore gardens, is now established in most parts of India where it is severe.

Miscellaneous. An account of the "Pythium" disease of ginger, tobacco and papaya, caused by a fungus named *P. Butleri* n. sp., with definite suggestions for its control, has been published as a Memoir by Mr. L. S. Subramaniam.

Spraying with lime sulphur almost completely controlled apple mildew on one orchard in Kumaon when the disease was very severe on a neighbouring unsprayed orchard. Spraying with lime sulphur, Burgundy mixture and Berger's lime proved very efficacious in controlling peach leaf curl (*Exoascus deformans*) in Peshawar and Kumaon, and there was scarcely a single case of serious disease in the sprayed areas. In Bombay, the spraying of vines with 3 lb. of copper sulphate, 2 lb. of lime and $2\frac{1}{2}$ lb. of soft soap, mixed with sufficient water to make up a solution of 25 gallons, has continued to give excellent results against vine mildew. It has become popular with the cultivator, and has raised a dying cultivation to prosperity again. Interesting results have also been obtained from the spraying of grapes in the Salem district in Madras against mildew.

The seed treatment of *jowar*, with copper sulphate, against smut, has proved to be perfectly successful in Bombay, Madras and the Central Provinces, and only wants more energetic pushing in the districts. Further study of various grain smuts is in progress and promises results of value.

Storage rots and other diseases of potato have been receiving the attention of the department, especially in Bombay.

Among other mycological investigations in progress at Pusa are the diseases of fruit trees in Kumaon, *tokra* of tobacco and

a study of the species of *Helminthosporium* found on cultivated cereals and sugarcane at Pusa.

(*d*) Entomology.

With a staff of entomologists limited to four class I officers for the whole of India—two in the Imperial Department and one each in the provincial departments of Madras and the Punjab—in addition to one employed by the Indian Tea Association, it is idle to look for much progress in the education of the Indian cultivator to the importance of insect pests and the possibilities of their control. The elucidation of appropriate methods of control is also necessarily hampered by the shortage of qualified officers to conduct both research and field work. The control of insect pests is a complex matter; and the conditions prevailing in the various parts of the country differ widely; so that it is not possible to prescribe any general methods for all pests. In most cases, not only the life-history and the habits of the insect concerned but also the crop it attacks, the environment, the weather conditions, etc., have to be thoroughly studied before the most effectual preventive measures can be ascertained.

Nevertheless, steady progress has been made on scientific lines by the existing staff of entomologists in working out the life-histories of most of the insects afflicting Indian crops and of their parasites. A summarized account of Indian crop-pests by Mr. T. Bainbrigge Fletcher, Imperial Entomologist, and a large number of other interesting papers on the pests of cotton, fruit trees, sugarcane and cereals, were read at the third entomological meeting, the proceedings of which will shortly be available. The following paragraphs review the more important investigations and operations carried on at Pusa and in the provinces during the year under report.

Cotton Pests. A study of the relative immunity of the different varieties of cotton was continued at Pusa and certain varieties were found to enjoy a partial, though not a complete, immunity from bollworm attack. Work on these lines was considerably hampered by the infestation of the cotton plants with *Pseudococcus corymbatus* and *Phenacoccus hirsutus*, and later

with *Eriophyes* sp. The life-history of the former has been worked out, together with those of its parasites and predators.

Of the trap-crops for bollworm larvæ, *Hibiscus abelmoschus* again proved to be the best, as the pods and shoots of this plant contained a relatively larger number of parasitized bollworms than did either cotton or any other trap-crop so far tried.

In the Punjab, both in the Lower Chenab Colony and on the Lyallpur farm, bollworms attacked the *deshi* more than the American cottons. Parasite boxes were distributed in several places to control the ravages of the pest.

A Gracillariad (*Acrocercops* sp.) larva was observed for the first time to mine under the bark of cotton at Pusa. It is an extensive borer and causes a layer of bark to peel off the entire stem and even from the leaf-stalks.

Rice Pests. Stem-borers in rice were under observation in Pusa throughout the year. The damage actually done by them in the vicinity of Pusa did not exceed about 4 per cent., but a normal figure for the more important rice-growing tracts would perhaps be higher. Unusually large numbers of the three principal borers (*Schœnobius bipunctifer*, *Sesamia inferens* and *Chilo*) were found in the stubble, but they were pre-winter broods and could not do much damage to the ripening crop.

A new external agent of damage has been discovered in the form of a Chrysomelid (Halticine) grub which bores into the stems of rice and millet seedlings from outside and causes a regular dead-heart. This insect has occurred in some numbers and ranks as a pest.

Sugarcane Pests. At Pusa considerable attention was again paid during the year to the cane borers and other insects which, although not actual borers, produce effects in the crop, especially the young crop, similar to those caused by borers. The question of alternative foodplants for these pests was also studied. The treatment of borers by removal of dead-hearts has been found to be distinctly injurious to the young crop as it interferes with proper tillering and is therefore not suitable in the case of sugarcane. With the exception of *Scirpophaga xanthogastrella*, the borers which occur at Pusa do not cause much damage to the grown canes. It has been observed in the

case of several borers that the presence or absence of alternative foodplants greatly influences their prevalence in cultivated grasses. It, therefore, seems probable that their ravages in cultivated crops may be considerably reduced by the use of the alternative wild foodplants, but further investigation along these lines is necessary before any definite recommendation can be made with confidence.

Three species of Dynastine beetles caused serious damage to sugarcane on the Kamrup farm in Assam. On investigation it was found that the beetles were breeding in large numbers amongst the roots of various kinds of wild grasses growing over an extensive waste land in the midst of which the farm is situated. It seems that they occur there every year without doing noticeable damage to the cane crop. This year, apparently on account of the drought, the emergence of the beetles was deferred until rain fell in March, when an unusually large number of beetles attacked the crop, especially those portions of it where germination had been retarded by the drought. This is the first instance of *Heteronychus sacchari* beetles having been found to cause extensive damage to sugarcane.

Tea and Coffee Pests. The Entomologist to the Indian Tea Association continued his work on the tea mosquito (*Helopeltis theivora*). It has been found that in North-East India suitable treatment of soils goes far towards alleviating the damage done by the pest. In Southern India, *Helopeltis* has continued to be the worst insect pest on tea. A combination of spraying, pruning large areas, burning the twigs and hand-catching is usually employed there, but these give only a limited measure of control and do not materially help to stamp out the pest. Sporadic outbreaks of *Thosea cervina* have been easily controlled by hand-picking, collection of cocoons and cultivation of the soil round the affected bushes. *Aspidiotus camelliæ*, the yellow bark-louse, is found to be controllable by fish-oil-resin sprays.

Pseudococcus (*Dactylopius*) *citri*, a mealy-bug scale, which attacks the roots of young coffee, is a bad pest, especially in South Coorg and certain parts of Mysore. It is also found on the roots of certain shade trees and weeds. At the beginning of the dry weather it is usual to see young plants suddenly wilt and

die on account of the scale. A similar effect is produced by the larvæ of a species of Cockchafer, *Holotrichia conferta*, which occasionally appears in very large quantities. Against both these pests, apterite, a mixture of crude naphthaline and pink carbolic powder, has been found effectual. Complete protection is afforded to the plants if a shallow trench about an inch deep is made in a ring round the young plants about 6 inches to a foot away from the stem and an ounce of apterite is placed in the trench and covered with soil. Care must, however, be taken that the young feeding roots do not get damaged by coming in actual contact with the apterite.

The most efficient remedy against the coffee borer (*Xylotrechus quadripes*), so far discovered, is to scrub the stems of the bushes in October-November with coconut husk to destroy and dislodge the eggs which are laid in the crevices and under loose pieces of bark.

Indigo Pests. Investigations regarding the parasitization of Indigo Psylla (*Arytaina isitis*) were continued at Pusa. Three species of Chalcididæ were concerned, but only one of them was very prominent. The parasitization was found to be highest at the end of May and September, but after the latter date it declined gradually until the minimum was reached in February.

Grain Storage. Experiments started at Pusa in 1915 to find out successful methods of preserving grain in stores against insect pests were concluded during the year. A paper by Messrs. T. Bainbrigge Fletcher and C. C. Ghosh containing the results of the experiments and the methods recommended for storing cereals, pulses, etc., has been included in the Proceedings of the Third Entomological Meeting.

Lantana. Work on this weed pest, taken up in November 1916, with the object of collecting information regarding the occurrence within the Indian Empire of any insects which may be utilized as special checks on its growth, was brought to a close at the end of March 1919. A complete report on the work by Mr. Y. Ramachandra Rao, who was placed on special deputation to carry out the investigation, is now in the press and will shortly be published as a Memoir.

"Tukra" of Mulberry. It has been definitely ascertained that the "Tukra" or "Kokra" disease of mulberry is caused by a mealy-bug (*Phenacoccus hirsutus*), which is found on the plants together with *Pseudococcus virgatus*. The nymphs as well as the adult females congregate on the shoots of the stems and cause their malformation in infested mulberry plantations. The growth of the affected plant is retarded while the lower lateral leaves become wilted and drop off. The affected apical leaves, if served to mulberry silkworms, cause "flacherie." The presence of this mealy-bug is indicated by ants (*Monomorium indicum*) which attend the scale insects for the sake of their honey-dew. Ten generations of *Phenacoccus hirsutus* were reared at Pusa during the year and its parasites and predators were also studied, together with the means of its dispersal and the best method of treating affected plots.

Miscellaneous. Special attention was paid at Pusa to the collection of information regarding fruit pests. A paper entitled "An Index to Indian Fruit Pests" by Mr. Misra, summarizing the information, has been included in the Proceedings of the Third Entomological Meeting.

In Madras, an organized campaign was undertaken against the paddy Hispa, with some success.

In Bihar, Mr. H. L. Dutt carried on experiments in connection with the control of *Agrotis ypsilon* in *char* lands by means of the parasite *Microgaster* sp. under artificial control of temperature and moisture conditions. The aestivating parasites which ordinarily remain dormant throughout the summer and the rainy season, emerged as adults in May last but in the absence of host caterpillars, which died on account of excessive heat in May, the parasites had no opportunity to multiply for the purpose in view. The work is being continued with a fresh lot of caterpillars collected from Shillong.

The eradication of *hurhur* weed (*Cleome chelidonii*) in the Mokameh *tal* had no effect on the incidence of *Agrotis* attack.

In Assam, operations against swarming caterpillars by means of a net dragged over the field met with some success, especially in Kamrup. In the same district attacks of army worms were controlled by dragging ropes over the crops and by

placing heaps of grass in the fields to act as traps. In the case of attacks of rice bugs at Nalbari, bagging is reported to have proved effective. Mustard sawfly was checked at Jorhat farm and in some villages near Gauhati by dusting the crop in the early morning, when the plants were wet with dew, with a mixture of powdered soil and lime sprinkled with kerosene oil.

Useful Insects—Bees. The work on the local variety of bees (*Apis indica*) was continued at Pusa. From numerous enquiries about matters relating to bee-keeping it appears that the public has begun to take a lively interest in the subject. Several improved hives were prepared locally and supplied to various correspondents. A Bengali Bulletin on Bee-keeping was published during the year and the first edition has already been nearly sold out.

Lac. The October crop of lac at Pusa was fairly good but the June crop was poor, having been adversely affected by the unusually hot weather during May. Brood-lac was supplied to various applicants, and two students were trained in lac-culture. At the request of the Forest Department, the Government Entomologist, Madras, has undertaken a small experiment in the cultivation of lac on *Zizyphus* trees in the Bolampatti forests with fair chances of success.

Silkworms. As an outcome of the recommendations made by Professor Maxwell-Lefroy in his report on the sericulture industry in India, a protozoologist has recently been added to the staff of the Imperial Department of Agriculture in India to investigate the diseases of silkworms. The establishment of a central seed store depôt with a view to supply healthy seed to growers is under the consideration of the Government of India, and has been referred to Local Governments for their opinion. The establishment of such a central seed store must, however, await the results of the protozoologist's investigations.

At Pusa, work continues with the multivoltine mongrel races of mulberry silkworms which have been established by crossing univoltine and multivoltine races. It has been found that the yield of silk from the first generation of these mongrel crosses is always better than that in later generations which deteriorate gradually. Attempts are being made to prevent this deteriora-

tion by the infusion of new blood in the mongrel races. A race has now been established which, on crossing with univoltine races, changes the resultant mongrel races into multivoltines in five or six generations, so that any univoltine races can be made multivoltine in a comparatively short time. Mulberry and *eri* silkworm eggs were supplied to several provinces, Indian States and other applicants from all parts of India as well as to several foreign countries. One Pusa reeling machine was supplied to the Agricultural Department, New South Wales, and another to the Indore State. Many enquiries regarding rearing, reeling, dyeing, bleaching, spinning and twisting have been dealt with, and four students have received short courses of training in sericulture during the year. The work done on the "Tukra" disease of mulberry and that done by Mr. C. M. Hutchinson, Imperial Agricultural Bacteriologist, on the pebrine disease of silkworms are detailed on pages 75 and 83, to which reference should be made.

In Bengal, work on the improvement of the mulberry silkworm races by hybridization is in progress. The object is to evolve superior multivoltine hybrid races which will retain the good characteristics of the indigenous races and, at the same time, yield more silk. By selection from a very large number of hybrids, the department has now obtained four principal types of good promise. These races, which had previously been reared on an experimental scale only, have, since March 1918, been reared on a field scale with a view to avoid any chance of experimental errors. It is satisfactory to note that so far they have not shown any signs of degeneration.

In the Punjab, sericulture has received a great set-back on account of the failure of the year's crop due to late arrival of the seed from France. Necessary precautions have been taken to avoid the recurrence of such a mishap, and as the province has now got a whole time Entomologist it is hoped that the subject will receive more attention than it has hitherto been possible to give to it.

In Burma, the sericultural experiments at Amarapura were continued but considerable difficulty was experienced in supplying mulberry leaves to growers during the hot weather. Mr.

H. A. Thornton, C.I.E., I.C.S., has continued his efforts to start the industry in the Northern Shan States on sound lines, and has obtained from Pusa the services of two skilled men to give local training in the methods of rearing silkworms. Two demonstrators have also been posted to Paukkaung in the Prome district to train the silk-breeders there.

(*e*) Pathological Entomology.

For practically the whole of the year the Imperial Pathological Entomologist was on special duty, in connection, firstly, with the prevention of surra-transmission by Tabanidæ, more particularly among transport camels, and secondly, with the improvement of existing culicifuges for military use. Little has been done outside these special enquiries, but Mr. Patel, besides continuing his work on midges and completing the manuscript of a book on cattle-flies, has studied the parasites of domestic animals and birds and has made several new discoveries, including a blood-sucking muscoid larva with habits comparable to those of the "Congo floor-maggot." Messrs. Sen and Sharma continued their physiological work on mosquitos.

(*f*) Agricultural Bacteriology.

In a country like India where climate generally favours bacterial processes, the study of bacteria is of vast economic importance. One of the most important problems which presents itself for consideration by the agricultural department is the possibility of increasing the amount of nitrogen added to the soil by natural fixation of atmospheric nitrogen, and also the necessity of recognizing the danger of interfering with or reducing this valuable natural process by any injudicious methods of cultivation or cropping. To cite one instance of the scope of the problem, it was found in the Punjab that nitrogen to the extent of 30 per cent. of that already present in a soil under a single crop —wheat—was fixed in less than six months in one season, whereas during the following one the amount was negligible. The great variations in the amount of nitrogen fixed in the same soil in different years clearly indicate the possibility of influencing nitrogen fixation by soil management without the necessity of

adding expensive materials. In present circumstances it is, however, possible to give but scant attention to the problem as there are no bacteriologists in the provinces to co-operate in the investigation. Similarly, numerous purely industrial problems, connected on the one hand with agricultural or other allied industries and on the other with biological research, are continually coming up for consideration. Mr. Hutchinson's work on saltpetre, indigo, silk, alcohol and sterilization of water furnishes instances of the kind. The necessity of adding agricultural bacteriologists to the provincial cadres for the investigation of bacteriological problems connected with the soil and agricultural industries has been urged by the sectional meeting of agricultural chemists and bacteriologists as well as by the last Board of Agriculture in India, and the subject will receive due consideration.

Proposals for an expansion of the bacteriological staff at Pusa to admit of two separate sections being formed, one for soils and plant bacteriology, and the other for industrial investigations, under the general control of the Imperial Agricultural Bacteriologist, have recently been sanctioned by the Secretary of State for India, and the revised staff is expected to meet the requirements of the Imperial Department for some time to come.

The progress of work during the year is reviewed below :—

(*i*) Soil Biology.

Nitrification. The results obtained from field and plot observations of seasonal variations in nitrification in soils under crop and fallow, confirmed the opinion that movement of soil water either upward or downward, whether caused by surface evaporation, by plant absorption (transpiration), or by drainage, conduces to increased formation of nitrates and that plant absorption accounts for the greater total nitrification found in cropped as compared with fallow plots. Nitrifying bacteria perform their specific function even under conditions adverse to their multiplication, such as the presence of specific toxins, an excess of organic matter or of ammonia, etc., the immediate oxygen requirements of the nitrifiers being generally satisfied.

in almost any soil. Water-logging during the monsoon, however, conduces to the development of toxin-producing bacteria and to the bringing into solution of excessive amounts of organic matter which tend to depress the nitrifying flora as an indirect effect of anaerobic conditions. The nitrifying flora, eliminated by adverse conditions, can therefore be re-established annually by careful soil management. The addition to the soil of inert material of large superficial area such as broken brick and potsherds appears to provide a suitable nidus for the development of nitrifying bacteria but some allowance has to be made for the frequently high content of nitrate, generally as saltpetre, found in such materials in Bihar.

A considerable amount of work was done by Mr. N. V. Joshi, First Assistant to the Imperial Agricultural Bacteriologist, on the rates of nitrification of various organic materials in soil. These included various green manures and other plants, and oil-cakes, and it was found that the non-nitrogenous portion had an inhibiting action upon the nitrification of the nitrogenous fractions. A paper on this subject by Mr. Joshi has been published in the Indian Science Congress Number of the "Agricultural Journal of India," Vol. XIV, Part III, 1919.

Further experiments on the inhibition of nitrification by toxins resulting from anaerobic incubation of soils, and by excessive quantities of nitrogenous matter were carried out. It was found that nitrification took place even in a soil in which there was sufficient free ammonia to be detected by smell and litmus reaction.

Green-manuring. Green-manuring experiments were continued at Pusa by the Imperial Agricultural Bacteriologist in collaboration with the Imperial Agriculturist. These experiments begin to show the valuable residual effect of such treatment on Pusa soils, especially with fermented green manure (*Crotalaria juncea*).

Nitrogen Fixation. Further work on fixation of nitrogen by legumes was carried out at Pusa. It was found that even in cases, where nodule formation did not occur owing to the use of strains of the *radicicola* organism foreign to the plant, the latter benefited by the supply of nitrogen a-symbiotically fixed in

the soil to which such organisms were added artificially. Similar results were also obtained with azotobacter inoculation and by the growth of legume bacteria in artificial media. In the case of *B. radicicolă*, no residual nitrogen was, however, found in the culture sand, suggesting that fixation of nitrogen proceeded *pari passu* with its removal by the growing plant, but with azotobacter this was not the case. A Memoir embodying the results of these experiments is in the press and will be published shortly. The possible symbiotic relation between green algæ and nitrogen-fixing organisms in soils formed a subject for investigation by the Supernumerary Bacteriologist as a continuation of his study of azotobacter in India.

In the Punjab, Mr. Wilsdon was engaged in determining the rate of the nitrogen fixation during the *kharif* fallow throughout the province. The results showed great fluctuations. In certain soils he found nitrogen fixation amounting to an addition of as much as 30 per cent. to the nitrogen content of the soil during the year, while in others no appreciable increase was detected. The factor which leads to this important process of the natural recuperation of the soil is worth determining, as its discovery may put us in possession of a means of drawing upon the inexhaustible supply of nitrogen in the air. Cultural experiments in soil media proved that the amount of nitrogen fixed by bacteria was greater in the presence than in the absence of protozoa. Since protozoa feed on bacteria of the azotobacter type, the result is somewhat surprising.

A study of the nitrogen fixation in the Central Provinces soils is also in progress. The biological analysis of embanked wheat soils of the Jubbulpore tract indicate that cultivation during the rains stimulates oxidation and nitrification, and that in embanked fields, the crop suffers in its early stage from nitrogenous starvation or from the accumulation of toxic substances or both.

(*ii*) Indigo.

Various strains of indican hydrolyzing bacteria, isolated at Pusa, were cultivated on agar made up with indigo leaf extract, and it was found that very little growth or hydrolysis took place in media in which indican was the only source of nitrogen,

whereas the addition of small quantities of leaf extract activated this at once. The physiological aspects of the question are being studied.

Manufacture. Further experiments on the hot water extraction method, referred to in the last year's report, were carried out in the experimental factory at Pusa. The use of lime precipitation following extraction and preceding inoculation with hydrolyzing bacteria was found to be an improvement of great value as it not only yielded a higher percentage extraction of indican present but also a product of greater purity. Experiments were initiated in the use of hypochlorite sterilization of the water and plant for elimination of undesirable bacterial flora as an alternative to hot water extraction. This would no doubt be a cheaper method, but it is not yet clear whether it will be possible to obtain the high percentage extraction of indican given by the latter process.

In connection with the manufacture of indigo in cement-walled vats, a point of great practical interest arose when the work was started last season. It was found that, owing to the " weathering " of the cement-lining surfaces of the vats during the period intervening between the manufacturing seasons, lime was set free by disintegration in quantity sufficient to produce in the steeping water an alkaline reaction of such a degree as to interfere seriously with the growth and activity of the hydrolyzing bacteria. Fermentation was delayed to such an extent that even after 12 hours, when this process should normally be complete, it was only just beginning. It was found necessary to add considerable quantities of acid (250 c. c. of 50 per cent. sulphuric acid per 600 gallons) to neutralize this alkalinity. Apparently, the " warming up " of the cement-walled vats, usually noticed in factories at the beginning of each season, is due partly to the removal of the disintegrated lime from the walls and partly to the gradual establishment of the necessary bacterial flora.

It is interesting to note that numerous reports have been received, from indigo factories, of improved yields resulting from the use of cross walls or other methods of increasing the wall area of the vats, recommended by Mr. Hutchinson as a

result of his discovery of the importance of bacterial action in the fermentation of the indigo plant.

(*iii*) Pebrine.

Owing to the use of multivoltine races of silkworms in India and the generally insanitary conditions under which rearing is carried out, it is essential for the rearer to begin his season with disease-free seed. In default of this the rapid cumulative effect of any small percentage of disease initially present will, in the course of rearing the numerous broods characteristic of these races, inevitably result in the failure of a fatally large proportion of the worms. For this reason it is necessary to adopt in India a much higher standard of purity in the seed issued by *grainages* than is customary in England. The method of examination of moths devised by Mr. Hutchinson to meet this necessity, referred to in the last year's report, has been adopted by various *grainages* in India and favourable reports on the success of its use are being received. Mr. Hutchinson was engaged in further study of the problem of elimination of this disease which included trial of the effect of hill-rearing upon the natural resistance of the larva to infection. Experiments were carried out at Shillong during August and September and it was found that even in the first generation a considerable increase in resistance to infection was obtained in the hill-reared larvæ. Eggs from the latter were transferred to Pusa both from infected and from disease-free moths, and further resistance to infection in the plains was noted in the latter, whilst in the former a smaller percentage of infected larvæ resulted from the hatching out of seed from the diseased moths. The infected larvæ survived through a greater number of moults and a larger percentage of them attained maturity than is usual in such cases. It was also noted that the hill-reared worms produced better cocoons. A Memoir by Mr. Hutchinson on the mechanism of infection and the elimination of pebrine in India is now in the press.

(*iv*) Sterilization of water.

At the instance of the Stores Department of the Indian Medical Service, Mr. Hutchinson investigated the problem of

sterilization of water. The Army Department deputed Captain W. Hodgkinson, R.E., to assist Mr. Hutchinson in the electrical side of the work. It was found possible to produce a hypochlorite solution containing from 3 to 4 per cent. available chlorine by electrolysis from purely Indian raw materials, thus avoiding the use of imported bleaching powder and having the consequent advantage of avoiding the great loss of chlorine in transit and in store incidental to the use of "bleach." The method for preparation of this solution (now known as "E. C.") has been so simplified that it can be prepared anywhere where electric current is available, and can be made of standard strength merely by reading figures on an ordinary current meter without expert knowledge either of chemical or electrical methods. The principal difficulty encountered has, however, been to obtain a sufficient degree of stability to allow of storage for such periods of time as may be necessary for transport to situations where electric current is not available. The degree of stability possessed by "E. C." varies inversely with the temperature of storage, but owing to the method of preparation and the use of an appropriate stabilizer it should be sufficient to ensure its efficiency under most conditions likely to be encountered. Further work is now being done to ascertain the most efficient form of apparatus for production of this solution on a practical scale.

(*g*) Agricultural Engineering.

The general feature of the department's work on agricultural engineering and the problems it has to deal with in this field, were outlined in last year's report and need not be repeated. The same initial difficulty of shortage of staff has militated against material progress here as has already been noted in other branches of the department's activities; and Bombay, Madras, the United Provinces and the Punjab are still the only provinces whose provincial agricultural cadres include permanent appoinments of agricultural engineers. The exceedingly high level, which the prices of all improved agricultural implements and appliances, together with the raw material for their manufacture, have maintained, has also seriously retarded their more general introduction. In these circumstances it is not

surprising that comparatively few opportunities presented themselves for opening up new lines of development.

In **Bombay,** operations extended considerably as a result of the department's activities in ameliorating the famine conditions prevailing in the Presidency. A large number of pumping sets worth Rs. 92,434 were purchased and distributed, four special installations costing Rs. 1,12,963, were provided in the Nerbudda, Godavari and Kistna rivers, and about 239 bores were made.

In **Madras,** certain amount of work was done in erecting new pumping installations, and 267 successful bores for water were made, of which three were artesian. The use of bamboos for lining boreholes, Mr. Newland considers, has considerable possibilities, and several holes were successfully lined in this way. The experiments with the two sugarcane crushing plants were continued, but have not gone very far in clearing up the problem.

In the **Punjab,** two methods of well-boring are employed. One is to pierce the impervious stratum and tap the water-bearing strata lying below, thus adding a considerable waterway area to that of the existing well. The other method is to introduce a strainer tube into a bore made to a considerable depth below the floor of the existing well in areas where no impervious stratum in the subsoil is found at a reasonable depth. This method generally results in trebling the supply of water. The number of bores sunk during the year was 349 of which 271 were successful, while the number of wells treated with convoluted strainers amounted to 158 without a single failure. Work on tube wells was practically at standstill owing to shortage of staff. The tube well installation at Chak Hiraj in the Ferozpore district has, however, been completed and yields one and a half cusecs.

Several implements have been designed by the Agricultural Engineer to suit the local conditions. Of these, a clip for quickly attaching tines or working points to hoes, cultivators, harrows, etc., without the use of bolts and nuts, is a notable example of practical achievement.

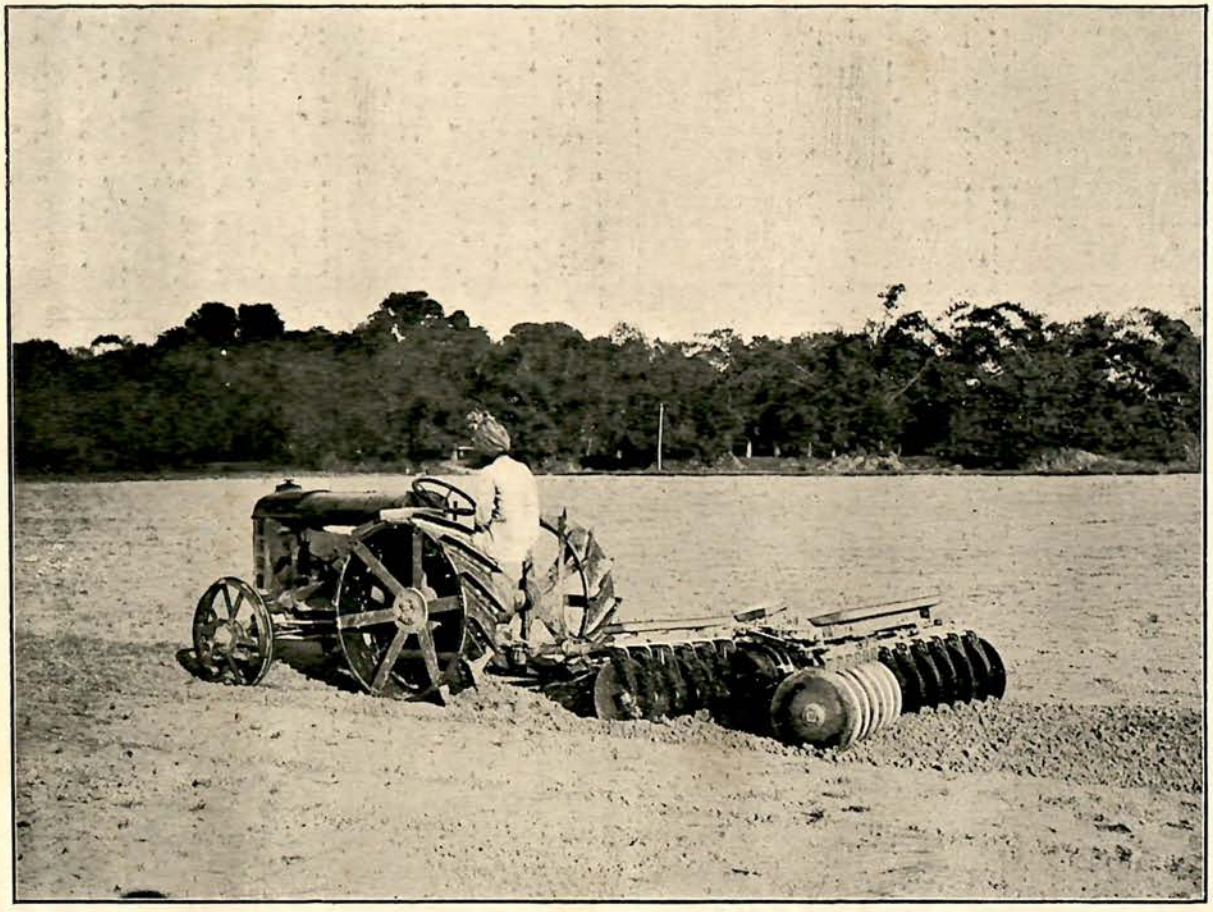
Investigations are in progress into the flow of water through sand of the various types found in the Punjab. Their object

is to obtain data for ascertaining the ultimate depression head necessary to obtain a given supply of water from a well.

To alleviate the effects of the drought of 1918 in the **United Provinces,** every available engine and pump was lent to cultivators, and 12 pumping sets were temporarily installed on rivers and tanks to bring as large an area as possible under crops. On a moderate estimate some nine to ten thousand acres were saved. In spite of adverse conditions created by the war, the agricultural engineering branch of the department has, during the five years of its existence, put down 61 strainer tube wells, and has installed 41 pumping plants over rivers, large tanks or existing masonry wells. Some 30 engines and pumps, mostly of small power, have been installed on wells, mainly in the western districts. The demand for pumping installations has continued to be great but, owing to the scarcity of plant of all descriptions, it has not so far been found possible to meet it except to a very limited extent. A new form of tube well to suit special geological conditions was tried at the Lucknow Horticultural Gardens with successful results. With an engine and a pump, the well gave ample supply for the whole area. It is cheaper than some of the other forms and will be tried in other localities suited to it.

In **Burma,** the services of an engineer were loaned again to the department from January 1919, and were utilized in the preparation of plans for the proposed Juvenile Jail Farm at Meiktila, the Government ginnery at Mahlaing and a proposed co-operative ginnery capable of turning out 720,000 lb. clean cotton per working season and of undertaking baling and dealing with all by-products. He has also been engaged on a design to improve the indigenous cane-crushing machine. In connection with the development of this branch of work, the Director reports as follows :—

"There is unlimited scope for the development of agricultural engineering in the province and it is doubtful if one officer will be equal to the demand, but a solution will probably be found by appointing agricultural engineers on the industrial side to advise people on power installations. The wind mill erected by Maung Ba Gyaw at Nyaungbinwin for a private individual is said to be working satisfactorily. The Burman has a natural bias towards mechanics and if a suitable machine is forthcoming, there will be no trouble in getting it adopted."



FORDSON MOTOR TRACTOR WORKING WITH DISC HARROWS.

PLATE I.

In **Mysore,** the appointment of an agricultural engineer with a small staff has been sanctioned during the year. Much of his time was taken up with construction work on the various farms, and he could not, therefore, devote greater attention to the important work of designing and adapting agricultural implements to local conditions. Besides putting up a power crushing mill at Hebbal with an additional gear, he succeeded in manufacturing a disc harrow on the model of the "Flying Dutchman." Some of his other improved implements are under trial.

The possibilities of **Motor tractors** in Western and Southern India appear to be considerable and necessary tests with them are in progress. At Pusa, a Fordson motor tractor, the first of its type in India, is under trial. With regard to its work and suitability, Mr. Wynne Sayer, Officiating Imperial Agriculturist, remarks as follows :—

"The tractor worked with implements in use on the farm and did all that it was asked to do in excellent style. It was hitched successively to a double furrow disc plough, a Ransome's cultivator, Cambridge roll and rake of three spring tooth-harrows, and afterwards was used to run the silage cutter. One could not fail to be struck with its work over ploughed land, which was good, thorough, and showed no sign of poaching the land or failing to get a driving grip. Its weight, 21 cwt. all on, appears to be the optimum for these operations. It is an extraordinarily handy machine and, with its light weight and great power, is well adapted to Bihar conditions. It is now working regularly on the farm and careful records are being kept of its fuel consumption, etc. A report will be issued in due course, and I take the opportunity of stating here that, pending the completion of thorough trials and the issue of this report, I am not prepared to express any definite opinion as to its capabilities. Any one wishing to see it working is welcome to do so. It is hoped to be able to run parallel experiments with other types of tractors this winter; and also to test fully the various types of implements provided with these tractors, and there seems little reason to doubt that many improvements can be made which will increase the capacity and efficiency of these tractors on Indian soils and thereby enable them to deal with a much larger area at a lower cost per acre. But to carry out of this work successfully, the co-operation of an engineer with agricultural knowledge is essential, and close collaboration with makers both of tractors and implements is essential and, when established, should prove of inestimable benefit to both sides."

CHAPTER IV.

PROGRESS IN DEMONSTRATION AND CO-OPERATION.

(*a*) Demonstration.

Extensive demonstrations of superior varieties of crops, methods of cultivation, implements, manures, etc., were carried out by the department on its demonstration farms, on cultivators' own fields and in shows and fairs. The importance of the work needs no explanation. It is the means by which improvements indicated by careful researches and experiments are brought home to the cultivator for general adoption in the field —the sole ultimate object for the fulfilment of which the department exists, and on the consummation of which the economic development of the country mainly depends. Several new demonstration farms have been opened and a large staff of *kamdars* (skilled farm labourers) has been employed for demonstration work. Besides these, other agencies such as agricultural associations, itinerant assistants and vernacular agricultural journals, are utilized for propaganda work. The scope for advertisement by leaflets and circulars is, however, limited in India on account of the illiteracy of the majority of our cultivators. Ocular demonstration has been found to be most effective in spreading improvements, and it is given wherever possible.

The work of enlisting the aid of co-operative and private bodies to assist in the dissemination of agricultural improvements of all kinds has proceeded on the lines indicated in last year's report. The more important forms of provincial activity are indicated below.

Madras. Demonstrations of improved methods of cultivation, use of iron ploughs, pans and mills, etc., and seed distribution of selected strains were conducted on the usual lines. As instances of the progress made, in the Tinnevelly district alone the ryots used implements introduced by the department on more than 17,000 acres of land during the year under review;

and the cultivators in Madura, Chingleput, Trichinopoly, South Arcot, Tinnevelly and Coimbatore are now growing green manure crops on their rice lands and ploughing them in over large areas instead of buying and carting green manure leaves from waste lands at a much heavier cost. In the three districts of Tinnevelly, Kurnool and Bellary, there were over 60,000 acres under better kinds of local cotton, while Cambodia was very extensively grown throughout the southern districts. Improved types of sugarcane have also been introduced in Godavari, South Arcot and South Kanara.

As regards the supply of cotton seed, there was a very great demand for Cambodia seed, of which 300,000 lb. were purchased and sold at a small premium. From the Koilpatti farm and from the areas leased as seed farms, a total of 185,000 lb. of "Company" seed was obtained and sold at a premium of about Rs. 2 a *pothi* of 250 lb. The Director of Agriculture writes as follows regarding the supply of seed of this rapidly extending variety of cotton :—

"It will no longer be possible to keep track of "Company" seed, as it has become so universal that certificates are valueless and little premium will in future be paid for it. This will bring the seed unions, who grow pure seed for the department—and it must be remembered that the last word in selections has by no means been said—face to face with the serious problem of making a sufficient profit to recompense themselves for the trouble they are put to in keeping to our regulations. Formerly they did this out of the extra price they were always able to obtain for their seed, but this will no longer be the case. In the circumstances, I have approached the trade, and have obtained the approval of the Tuticorin Chamber of Commerce to a small cess of four annas a bale, to raise a fund which will be devoted to benefiting the cotton industry of the south, in various ways. One purpose to which this fund will be devoted will be to guarantee a premium to seed unions for the seed they grow for us."

Another most interesting development is the formation of a Cambodia Cotton Marketing Association in the Coimbatore district, on the initiative of Mr. Holmes, the local Agent of the Bank of Madras. The two main lines decided upon at a meeting held at Coimbatore in July 1918 were to establish the use of definite cotton standards for trading in Cambodia on the lines of those used in other markets, and to establish a

cotton market at Tirupur, the centre of the Cambodia trade. Standards have been prepared and the foundation-stone of the market has been laid by His Excellency the Governor of Madras.

Over 700 tons of guano and 22 tons of beach-dried sardines were purchased and stored. These are now being despatched all over South India. A special mixture made up of fish guano, mineral phosphate, castor-cake and bone-meal was distributed, by the district staff with the help of students from the senior classes at the Coimbatore Agricultural College, to 500 cultivators in about 300 villages in the Tanjore delta under an agreement which provided for a comparison of the yield of the manured and the unmanured plots. Some 500 tons of the special manure have been stocked and will be distributed during the current year. These are very promising lines of work and may be expected, in course of time, to effect a considerable increase in the production of food crops in the presidency.

Bombay. Propaganda work is carried out principally by means of depôts for the hire of implements, by demonstration farms and plots in many parts of the Presidency, particularly in the central division, by the personal efforts of the overseers themselves, especially in the distribution of seeds, manures, implements and material for the prevention of plant diseases, and by shows and demonstrations.

No less than 234,500 lb. of seed of fodder crops alone were distributed, and seeds of different food crops to the approximate value of Rs. 1,66,000 were purchased and stored for distribution. Similar work on manures was carried out at a cost of about Rs. 18,102.

Agricultural associations have been organized in many parts of the country and most of them are doing excellent propaganda work. Three of the most important of these are carrying on agricultural magazines in the vernacular. They evince genuine enthusiasm and contain the best cultivators in the province.

Bengal. The year has been marked by a general development of district work. The district staff now includes three Deputy Directors, a Superintendent for each administrative division and an Agricultural Officer for each district. Below the District Agricultural Officers there are 79 Demonstrators.

In accordance with the policy of the Local Government, which contemplates the establishment of departmental farms at the rate of three a year, until there is one in each district, the first three farms have been built and laid out at Mymensingh, Bogra and Comilla. These farms will be in charge of the District Agricultural Officer and will include a seed-store. They will be of the greatest use to the department for testing new varieties of crops, manures, etc., and for storing the seed required for the district. The main item of district work is the distribution of seed of departmentally selected crop varieties, the other items being demonstrations of the effects of manures, the introduction of groundnuts into Western Bengal, and measures against the *ufra* disease of rice. The Director reports in the following terms on the effect of applying in the cultivator's field the results obtained by the research officers :—

"The departmentally selected rice and jute at present occupy roughly 250,000 acres and 100,000 acres, respectively. Taking the average increased yield of the improved paddy and jute over local races which they have replaced, to be three maunds and two maunds per acre, respectively, we arrive at the conclusion that, in the present year, the Bengal cultivator will, in the aggregate, be better off, on this account alone, by about Rs. 40 lakhs (£250,000 sterling). The figure may be expected to increase rapidly, for practically the whole rice and jute crops of the province will probably be affected in quite a few years. In this case, the net income of the cultivators of rice and jute in Bengal would be increased by as much as Rs. 12 crores (£7,500,000 sterling) per annum."

Some of the agricultural associations are now taking a lively interest in the dissemination of improvements recommended by the department. In Birbhum, through the efforts of its Collector, Mr. G. S. Dutt, I.C.S., there is now a net-work of *thana* associations and even smaller societies comprising only three or four unions, which are doing excellent work. A somewhat similar development is also taking place in the Faridpur district. Genuine movements of this kind should go a long way to ameliorate the agricultural conditions of the province and these organizations will be watched with interest by all concerned.

Bihar and Orissa. Demonstrations of tested improvements, such as *Mungo* sugarcane which well repays special cultivation, or groundnuts which are new to cultivators in the

province, were continued on the cultivators' own lands by Agricultural Inspectors through *kamdars*. The system has been found to be more effective than that of giving demonstrations on a Government farm, and is more popular amongst cultivators. Its outstanding feature is that, once the cultivators are shown how to proceed with the new lines, the organization lends itself to a system of recovery or purchase of seed at harvest for distribution among other cultivators in the neighbourhood. Large quantities of seed of improved varieties of crops such as the Finlow variety of jute, Pusa 12 wheats, *Indrasail* paddy, etc., were distributed to selected cultivators, gratis, for one year's trial, in small parcels sufficient for about one-fourth of an acre.

Three-roller sugarcane-crushing mills and shallow evaporating *gur*-boiling pans were in great demand, and, as far as possible, these were supplied to the cultivators of *Mungo* sugarcane, either on loan or on hire. Some of the agricultural associations and co-operative societies in the province did excellent work in dissemination of improved methods of cultivation and distribution of seed. The extension of the cultivation of *Mungo* sugarcane and groundnuts in Cuttack, Puri and Sambalpur has mainly been effected by or through these agencies.

United Provinces. There was a good demand for seed from the seed depôts in these provinces, and in all 64,000 maunds, the bulk of which consisted of Pusa wheats, were sold in addition to a very large number of cane setts.

On account of the high and uncertain prices it was not possible to keep the implement depôts regularly stocked, but 78 Meston ploughs were sold during the year. A small number of co-operative societies, mainly in the central circle, continued to engage in seed distribution, while numerous farms opened by zemindars in Oudh did excellent work in this connection as well as in demonstrating improved methods of agriculture and the use of modern implements. These farms now form a most useful connecting link between the department and the agricultural community generally.

The principal demonstrations, apart from the introduction of improved crops, included the harrowing of wheat after the

first irrigation to save irrigation water, the use of the ridger, green-manuring, drill-sowing of cotton, interculture of cotton, improved methods of *gur*-making, the correct use of iron ploughs and hot weather cultivation for wheat.

Land improvement schemes also are being carried out in Oudh on the reclamation of certain classes of *usar* land, and, in Bundelkhand, on the reclamation of land eroded by the action of water channels.

Punjab. The extension of the improved varieties of cotton and wheat, and the spread of improved implements have continued to receive the special attention of the department. From an allotment of Rs. 3,56,000 made for the purchase and sale of good seed out of the profits derived from the Government's wheat purchasing scheme, about 31,380 maunds of wheat seed and 51,190 maunds of cotton seed were purchased and sold to ryots. The transactions in wheat seed have yielded a profit of Rs. 56,135 : the corresponding figures for the sale of cotton seed are not yet available. About 400 maunds of *chari* seed also were sold to cultivators.

In consequence of a proposal made in the Bombay market to make Punjab-American cotton tenderable against a Broach contract, the department has been asked to prepare three standards of superfine, fully good and good American cotton. It is hoped that this standardization—which was one of the recommendations of the Indian Cotton Committee—will secure for the cultivator a proper premium for Punjab-American. Altogether twelve auctions of Punjab-American were held under the control of the department and two under the control of co-operative credit societies. In all, 122,321 maunds of cotton were disposed of at prices varying from Rs. 17-5-0 to Rs. 24-12-0 per maund. It is hoped that the co-operative societies will gradually be able to take over these sales altogether from the department.

District Boards, aided in initial outlay by grants from the wheat profits, are coming forward with proposals for demonstration farms. Altogether a sum of Rs. 2,25,000 has been earmarked by Government for this purpose; and steps are being taken to start farms at Jullundur, Ludhiana, Hoshiarpur, Sialkot and Amritsar, while several other District Boards,

notably those of Hissar and Shahpur, are anxious to follow suit.

Proposals to complete the wheat elevator at Lyallpur at a cost of Rs. 1,40,000 have been sanctioned. It is expected that the elevator will be ready for use by May 1920, and will have a steadying effect on next winter's prices.

The highly inflated prices of agricultural implements have again proved a hindrance to their spread. Only 396 imported implements could be sold during the year as against 725 last year. Besides these, 778 implements manufactured by the department were sold to cultivators.

Burma. Agricultural stations, sub-stations and district farms have continued to be the chief centres of demonstration of the improved methods of cultivation and of distribution of seed recommended by the department. The District Agriculturists play an useful rôle in carrying out the work. They supervise the distribution of seed and implements and manage the district farms, where such farms exist. The present system makes it essential that each district should have its own farm to " try out " new varieties of crops and new methods of cultivation recommended by the experimental stations, and to serve as depôts for the collection and distribution of seed, the cost of which will otherwise enhance on account of additional railway freight, etc. Most of the co-operative societies help the department in undertaking experiments and in multiplying the department's seed. The excellent co-operative spirit which exists in Burma gives an impetus to the quick dissemination of improvements.

In the Northern Circle, 7,931 baskets of *Ngasein* paddy, 5,148 lb. cotton seed and 5,824 lb. of selected gram were distributed. An effort was made to push wheat, and over 4,000 baskets of seed were issued, the bulk of which was taken by the Shwebo district where the Deputy Commissioner gave seed, instead of cash, as agricultural advances. There was also a considerable distribution of miscellaneous seed.

The Southern Circle dealt with 4,834 baskets of pure strain paddies, 32,381 lb. of selected strains of cotton, 7,931 lb. of groundnut and 13,024 lb. of *pebyugale* (small white bean) in

addition to smaller quantities of seed of miscellaneous crops, the more important of which were jute (500 lb.) and Pusa tobacco (40 lb.).

Cyprus ploughs were in considerable demand but, like other European implements, were almost unprocurable at a reasonable price. The question of designing and manufacturing suitable farm implements for local needs is being taken up by the Deputy Directors of Agriculture and the Agricultural Engineer. Implements and cotton gins worth about Rs. 2,279 were sold during the year.

The complaint about bad germination of seed referred to in the last year's report was not repeated during this year. The source of trouble was traced and removed. The power threshing machines were not responsible for the bad germination of the paddy threshed, but it was due mainly to heating in the stalks. Germination tests carefully carried out during the year indicated no difference between machine and bullock threshed paddy.

Central Provinces. To help in the demonstration work in these provinces the department has successfully organized a large number of agricultural associations of which there is now one in almost every *taluka*. The propagation of improved strains of rice, wheat, etc., is mainly carried on through the agency of a number of private seed farms which are being gradually increased to cope with the expansion of the work. Some of the agricultural associations have also been led to organize co-operative shops for the sale of oil-cakes, copper-sulphate, improved seeds and implements, and also to hire out ploughs, etc. These associations have been doing most useful work in developing agriculture. But, in addition to these agencies, the department has its own seed and demonstration farms, and runs several small seed and demonstration plots of about eight acres each. These plots are worked at profits varying from Rs. 24 to Rs. 504, and are managed by Jamadars who devote part of their time to the demonstration of improved methods of cultivation in the neighbouring villages.

Great progress has been achieved in the extension of improved strains of paddy, wheat, cotton, *jowar*, sugarcane, groundnut, etc., and the consequent profits now being obtained

by cultivators must be very considerable. The use of sann-hemp for green-manuring paddy, the transplanting of single seedlings of rice, the sowing of wheat as a second crop after rice in irrigated tracts and the irrigation of wheats under Government tanks and canals, which add largely to the profits, are being successfully pushed by the department.

In the Southern Circle, the number of private seed farms rose this year to 134 for paddy and to 58 for wheat. In spite of the unfavourable season, the area of transplanted rice in the Chhattisgarh division was just over 40,000 acres against 41,821 acres in the previous year, while that of irrigated wheat rose to 4,688 acres from 3,709 acres in the previous year; 13,223 lb. of sann seed and 57,396 lb. of costor seed were supplied by the department to cultivators in the division. Implements to the value of about Rs. 14,100 were sold by the implements depôts of this circle, and over 121,058 lb. of Pusa 13, Pusa 100 and *sukerhai pissi* wheats by private seed farms.

In the Nagpur Division much attention was given, as usual, to the transplanting of single rice seedlings as opposed to bunches; 41,533 acres were transplanted in Chanda district in this way as against 26,953 acres in the previous year. An effort was made in the year to increase the area under Chanda cold season *jari* cotton by distribution of about 100,000 lb. of seed, and the area cropped with it in Chanda alone rose to 86,000 acres this year.

In the Western Circle, there were 22 registered unions, 4 unregistered unions and 365 private seed farms working during the year under Government supervision. They produced over two million pounds of selected *roseum* seed. Over 5,000 lb. of *buri* cotton seed also were distributed from the Akola farm and 3,000 lb. from the Amraoti district for growing in wilt-infected areas. The Taluka Associations in Amraoti district distributed 30,000 lb. of groundnut and 13,600 lb. of selected varieties of *jowar*. The co-operative shops run by agricultural associations made large sales of oil-cakes, copper-sulphate, improved seeds, implements, etc.

In the Northern Circle, the demand for improved seed and implements has outstripped the supply by private seed farms

of which there are 204, and to meet the situation the department has opened new seed and demonstration farms in Betul, Jubbalpore, Saugor, Damoh and Seoni. Every district in the circle, except Narsingpur and Mandla, has now got its own Government farm or farms, and it is expected that it will soon be possible to meet the increasing demands for seed and implements. Besides these larger farms, there are several small seed and demonstration plots run by the department. The total quantity of seed distributed by the Government seed farms in this circle amounted to 366,413 lb., including 278,155 lb. of wheat; 163,267 sugarcanes were supplied, 47 improved furnaces for *gur*-boiling were constructed and implements to the value of Rs. 16,516 were sold. With a view to popularizing and organizing the district work, 27 new *tahsil* agricultural associations have been formed, some of which have started co-operative shops for the sale of improved seed, implements, etc. The cultivation of groundnut is being extended all over the circle.

Assam. The work done during the year consisted chiefly in variety and manurial demonstrations with rice and sugarcane on cultivators' holdings, the introduction of improved varieties of potatoes and jute, and popularizing three-roller iron sugarcane mills, Meston ploughs and the system of storing cattle manure in covered pits and sheds. The honorary correspondents, of whom there are 31 and who perform the same functions as agricultural associations in other provinces, give a considerable amount of help in the demonstration work of the department.

In the Saidiya frontier tract, new varieties of crops including sugarcane, potatoes, *aus* paddy and wheat were successfully introduced. Terracing for wet rice cultivation produced excellent results at Pasighat and Rotung. Demonstrations were given of the advantages of using larger seed in potato cultivation which proved that an increased outturn amounting to 4,333 lb. per acre in Kamrup, 2,346 lb. in Sibsagar and 2,032 lb. in Nowgong could easily be obtained. Green-manuring as a preparation for sugarcane was demonstrated in Sibsagar with cowpeas and in Kamrup with *dhaincha*. It was proved that by the adoption of the method recommended an average increase of 992 lb. of *gur* per acre, valued at Rs. 60, could easily be

secured by cultivators in Sibsagar, and of 1,913 lb. of *gur* per acre, valued at Rs. 116, by those in Kamrup at a small cost of Rs. 2 to Rs. 4-8-0 per acre for seed. There are only two seed depôts of the department—one at Gauhati and the other at Sylhet. Thirty-six tons of seeds and manures, and 78 implements were issued from the depôt at Gauhati, while from the Sylhet depôt, 7 tons of potatoes, 1 ton of paddy, 1,107 lb. of jute, and 21 tons of bone-meal were dealt with. Besides these, over 3½ lakhs of sugarcane setts were distributed from the Jorhat farm and 38 sugarcane mills were sold during the year. In order to extend the cultivation of the selected varieties of rice, *Indrasail* and *Georgesail*, arrangements have been made to distribute 40 maunds of the former and a few maunds of the latter in 5-seer bags this year.

The measures taken to check the spread of water hyacinth were continued on a larger scale. Large quantities of the weed were collected and burnt, and some 25 tons of ash were prepared. Arrangements were made for the sale of the ash at rates which would have been remunerative had the potash content been equal to that found in the small scale experiments. Proposals to enable cultivators to put pure potash salt upon the market at profitable terms, by means of a subsidy, are under consideration of the Local Administration. In any case, it is a hopeful sign that the use of the ash or of the rotted plants as manure is spreading.

Mysore. The outstanding feature of the department's work was the distribution of seed on a large scale with a view to increase rapidly the stock of food grains in the State, and in this attempt the department scored a considerable success. About 1,107,865 setts of Red Mauritius sugarcane have been distributed, and it may be said that it has now been introduced in practically all important tracts and will extend in areas on its own merits. The improvements in *jaggery*-boiling and the better furnace and mill recommended by the department are being extensively adopted. Demonstration of seed selection by the salt water method and of the selection of good earheads on the field was continued in addition to distribution of large quantities of improved and selected seed of various crops. The activities of the department in this latter direction are bound

to increase with the realization of the advantages of improved seed. The sale of implements is reported to have suffered owing to shortage of supply, but, in spite of it, 20 sugarcane mills of the Nahan pattern, 1,038 ploughs, and 62 cultivators were sold, in addition to 1,779 spare parts. The interest of co-operative societies was successfully enlisted in the department's seed distribution work and about 40 maunds of various seeds were distributed through this agency. They also stock manures, implements and sugarcane mills for sale and hire.

(*b*) Co-operation.

Nothing is more difficult than to establish a criterion by which the rate of progress in co-operation in different parts of India can be judged. The number of co-operative societies, their membership and their working capital are no doubt important factors, and, in these, almost all provinces indicate progress during the year under review. The moral progress is, however, a matter still more difficult to gauge. While, on the one hand, several failures of co-operative societies are reported to be due to the selfishness and dishonesty of secretaries and chairmen or to mutual distrust among the members, a considerably larger number of societies have, on the other hand, carried on their different functions in a real co-operative spirit, not only to their own advantage, but also to that of the general public. Extravagance and litigation, two of the main evils responsible for the chronic indebtedness of the people, have received a considerable check in some localities through the influence and activities of co-operators. It appears that in the Punjab, where Mr. M. L. Darling, I.C.S., Registrar of the Co-operative Societies, recently made some enquiries into the financial conditions of the members of the societies in the province, ten years' co-operation has, on an average, reduced their indebtedness to a half, while there has also been an increase in their assets. A desire for a more extensive education has arisen in many parts of the country, and instances are not wanting in which co-operative societies have started new schools or have given scholarships to selected students.

It is gratifying to note that some of the provinces have taken up the overhauling of their co-operative organizations, have

wound up some of the societies which failed in the past to work on sound lines, and have formed new ones with better and more promising material.

The widespread famine that raged in the country during the year gave a set-back to the progress of a considerably large number of agricultural societies. In spite of this, several of them have continued to work on lines beneficial to the improvement of agriculture. Besides giving loans at low rates of interest for carrying on productive improvements, they have acted as agencies for dissemination of better seeds of crops and improved implements, etc. Co-operative societies for the joint purchase of agricultural requirements and for the joint sale of their members' produce are increasing in popularity. A demand has arisen for jointly owned expensive oil-engines, pumps and other agricultural machinery, beyond the means of individuals. There is a wide scope for the application of the principles of co-operation in this direction, but the high cost of machinery prevailing at present stands in the way of rapid progress.

A noteworthy incident of the year was the formation of a Central Co-operative Institute in Bombay to serve as an educational, propagandist, research and advisory body, filling a rôle in the Presidency similar to that of the Irish Agricultural Organization Society at Dublin. It is expected that it will provide ample scope to non-official co-operators for their activities. The Bengal Co-operative Organization Society, started with somewhat similar objects in view, completed a year of very useful propaganda. An association, called the Bengal Agricultural Society, has also been formed during the year.

The agricultural and the co-operative departments have continued to co-ordinate the work of each other, wherever possible. As both these departments are engaged in attaining the common object of raising the economic condition of the cultivator and as their progress is inter-dependent, close co-operation is essential and desirable.

Bombay. The total number of agricultural societies (credit and non-credit) rose from 1,390 to 1,737, membership from 101,333 to 123,825 and the working capital from Rs. 71,99,815

to Rs. 83,60,371 during the year. There was also an increase in the profit from Rs. 1,49,724 to Rs. 2,89,870. Owing mainly to the adverse agricultural conditions of the year the average membership of societies has, however, dropped from 73 to 71, and the average working capital available per head from Rs. 71 to Rs. 68. Outside Sind, all agricultural societies have been formed on the Raiffeisen model. In Sind, societies are formed on an entirely different model based on the example of the Punjab as it satisfies Mahomedan sentiment with regard to interest, and encourages members to exercise thrift and accumulate capital by small monthly payments.

There are nine cotton sale societies in East Khandesh and Dharwar. They sold cotton valued at Rs. 9·72 lakhs and Rs. 8·68 lakhs, respectively. The work of the societies in Khandesh was seriously obstructed by the shortage of the crop, the absence of outside bidders and combination among local purchasers. It is a matter for regret that although big buying firms were requested to send their representatives to bid at the auctions they did not respond to the appeal. Without the co-operation of big buying firms, it will be difficult to break such combinations of local purchasers and to put the cotton market on a better footing. The question is of importance not only to the agriculturist but also to the trade, and it is desirable that the producer and the buyer should come to a better understanding in the matter.

Inspite of great difficulties in obtaining railway transport and the diminished demand for cake manure owing to famine conditions, the 21 manure purchase societies in the Presidency sold about 80·67 lakh lb. of manure during the year.

The seven seed societies and the 13 cotton unions in the province dealt with about 283,980 lb. of cotton and *jowar* seeds. The famine and the shortage of sufficient quantities of well selected seeds hindered the progress of these societies and unions during the year.

Apart from the implements maintained by the credit societies for sale or hire to their members, there are 12 implement societies in the province which invest the whole of their capital in the purchase of suitable implements and machinery, and meet

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their working expenses from the hire realized. Most of the societies worked at a loss during the year. In consequence of the famine, a keen demand has sprung up in the Deccan for jointly owned oil-engines and pumps and it will gradually be met as engines become available at reasonable prices.

The working of cattle-breeding societies received a very bad set-back from the drought. Of the 11 societies in existence at the beginning of the year, two were cancelled and four gave up their bulls. There were only two societies, one at Maroli and the other at Umbergaon, that maintained their bulls and continued breeding operations throughout the year.

Madras. There was a net increase of 777 in the number of agricultural credit societies. The total working capital of these societies rose from Rs. 97·93 lakhs to Rs. 122·95 lakhs. One thousand three hundred and twenty societies (of which 501 were new) worked at a loss of Rs. 1,56,715, and 1,661 societies at a profit of Rs. 1,71,616. Thus, the net profit of all the societies during the year was Rs. 14,901. These figures are rather discouraging, but the provincial Registrar of Co-operative Societies assures us that there is nothing really alarming about the state of these societies, which, in the majority of cases, is mainly due to their failure to collect interest on account of the unfavourable agricultural conditions of the year.

The number of societies for purchase and sale rose from 17 to 31, membership from 545 to 1,891 and working capital from Rs. 5,566 to Rs. 63,999. They made a profit of Rs. 1,344 during the year. A society has been formed at Tindivanam with the object of preparing the raw produce of its members for the market. It has purchased two gins and a 36-horse power oil-engine and proposes to purchase two decorticators for groundnut and a disintegrator for the manufacture of bone-meal. It has a substantial working capital and has a bright future, provided it works honestly and on right lines. The Kallakurichi society also has undertaken similar operations. The South Kanara garden planters' society is another interesting venture. Its main business is joint sale of areca and other garden produce through its agent in Mangalore. It did transactions on articles valued at Rs. 3,84,800, and it is estimated that the members

secured about Rs. 19,600 over what they would have obtained by selling through the ordinary channels. The society also did a considerable purchase of the domestic requirements for the members.

There was a slight extension of the system of joint purchase of implements for leasing to members. Twenty Monsoon ploughs, three crushing mills and two expensive *jaggery* pans were purchased by primary societies, unions and trading unions. There is ample scope for this kind of work.

Some progress has also been made in the direction of joint sale of the produce of members. The sales amounted to Rs. 50,343 and the profits were estimated at Rs. 2,415.

Bengal. The number of agricultural societies rose from 3,374 to 3,923, membership from 125,590 to 134,755 and working capital from Rs. 80,50,717 to Rs. 91,89,695 during the year. The working capital per member was Rs. 68.

There are five societies with limited liability for co-operative purchase and sale. Of these, three are small stores, but two—the society at Dewangunj and that at Khepupara—are important. The members of each of these societies have combined to sell their crops and to purchase their own requirements. The Dewangunj society, with a share capital of Rs. 2,698, purchased crops, mainly jute, worth Rs. 69,198, during the year and sold goods worth Rs. 13,424. The Sundarbans Supply and Sale Society at Khepupara increased its working capital from Rs. 11,942 to Rs. 56,496, did excellent work and cleared about Rs. 6,000 profit on its rice transactions alone.

The only society for production—the Khelar Irrigation Society—has had a prosperous and successful year. In the drought experienced in Midnapur district this year, the area irrigated by the society yielded four or five times as much per acre as the adjoining unirrigated lands. The provisions of the Land Acquisition Act, however, stand in the way of giving effect to some of the productive schemes of the society. It appears to be doing useful work and should receive greater facilities in carrying through irrigation schemes of importance.

Of the 23 societies for production and sale, 22 deal with milk. The remaining society—the Naogaon Ganja Cultivators'

Co-operative Society—did exemplary work during the year. Government now gives a license to the society alone for the sale and cultivation of *ganja* on an area of about one and a half square miles. The elimination of the middlemen or brokers has resulted in the cultivators getting the full value of their crop. The society paid excellent prices for the year's crop and made a profit of about rupees three lakhs. Yet it is but a beginning and the activities of the society are limited to a small area of 1½ square miles. The cultivators of the rest of the 80 square miles of the *ganja mahals* are now combining to deal with their crops. The organization of the society is based on sound lines, and it has now engaged the services of the Joint Registrar of Rajshahi Division as its chief executive officer. It has also engaged a veterinary assistant to attend to the cattle of the members, and has under consideration a scheme of cattle insurance of which every member may avail himself. Further, it has decided to invest a part of its reserve fund in the purchase of a farm to be staffed, equipped and stocked on the most modern lines to improve the local crops. It has also been doing very useful work in many other directions, *e.g.*, in the opening of schools, dispensaries, etc., and has spent Rs. 40,000 during the year on public objects in and about Naogaon. Another society in the locality, an off-shoot of the *ganja* society, has been registered after the close of the year to sell the other crops of the members and to supply them with necessaries.

Bihar and Orissa. The number of agricultural credit societies rose from 1,616 to 2,044, membership from 60,778 to 65,818 and working capital from Rs. 29,81,629 to Rs. 34,27,905. The working capital per head of members has risen from Rs. 49 to Rs. 52 but it is still very low.

The working of the agricultural associations has not been very encouraging. Most of them have failed to carry out their specific functions in matters relating to supply of seed, implements, etc., and sale of members' products in bulk. The Nawada society, however, did good work in popularizing Pusa wheats. The Fatwa store which has made its chief business to undertake the sale of the members' produce is still struggling on.

Apparently these associations are lacking in the true spirit of co-operation and business organization, and require more fostering both by the co-operative and by the agricultural departments till they are well established.

Punjab. The number of agricultural societies rose from 3,937 to 5,228 and individual membership from 125,040 to 148,069. The working capital rose from Rs. 1,37,52,460 to Rs. 1,55,21,099, and the profits from Rs. 8,64,298 to Rs. 9,08,331 during the year. These figures indicate a substantial advance and an awakening of interest in tracts hitherto un-stirred by the co-operative movement. The older societies have gathered strength and stability, and several new and interesting forms of co-operation have been started. The co-operative societies have now begun to undertake cotton auctions which have hitherto been managed by the agricultural department. A commission society, now being formed at Lyallpur, proposes to hold a series of auctions, and it is hoped that it will serve a useful purpose. Over 25,000 maunds of seed and 100 improved implements have been supplied by these societies. In eleven villages in Gurdaspur and Jullundur, prominent co-operators set aside small demonstration plots of one or two acres for cultivation of wheat, cotton and maize on improved methods recommended by the agricultural department, the yield on which averaged 40 per cent. more than on adjoining plots of land.

The number of agricultural societies for purchase and sale increased from 8 to 102, membership from 280 to 1,234 besides 971 credit societies formed into supply unions, and the working capital from Rs. 1,422 to Rs. 1,72,098. They made a profit of Rs. 5,306 during the year and dealt mainly with iron, fodder, cloth, etc.

The number of societies for production and sale is 39. In this class, the Shakargarh commission shop society is the most important venture. It has built a *pakka* godown capable of storing 10,000 maunds of wheat and 1,000 maunds of seed. Nearly 7,000 maunds of wheat are now stored there on behalf of 150 societies who are its members.

Incidentally it has introduced an element of competition into the local market and has thus compelled the local *banias* to pay

a full price for the cultivator's crop. The *ghee* societies failed to prosper. A poultry society has recently been started near Gurdaspur and its progress will be watched with interest.

Burma. The total number of co-operative societies rose from 3,056 to 3,612, membership from 73,702 to 88,860 and the working capital from Rs. 1,87,52,214 to Rs. 2,22,41,066.

Provision of long-term credit has not come to fruition except in case of one or two urban credit societies which have decided to utilize a part of the capital in long-term loans on mortgage security. The question of forming land-mortgage societies is still under discussion. The programme of colonization of special areas by co-operative agency was suspended for want of colonization officers. Some of these societies suffered considerable loss from bad harvest, floods or cattle disease. The unions at Pinbaw, Pintha and Hopin have had a prosperous year and, after paying instalments of principal and interest due, were able to deposit some thousands of rupees in the banks as a provision for future requirements.

There was a set-back in the activities of societies for sale of crops and for supply and distribution, apparently due to the conditions of the market in 1918-19. A society for the sale of paddy at Zigon in Tharrawaddy district has, however, been organized by local co-operators with high hopes and business-like intentions.

Central Provinces. The number of agricultural credit societies rose from 3,377 to 3,871, membership from 55,663 to 62,612 and the working capital from Rs. 57,48,913 to Rs. 69,40,497. Their total profit during the year also rose from Rs. 1,05,624 to Rs. 1,15,916. With regard to the relation between the primary credit societies and the banks, Mr. Crosthwaite remarks :—

" One of the greatest weaknesses in our system, however, is the over-dependence of the primary credit societies on the central banks, an over-dependence the danger of which is most serious in the case of a central bank which is deep in the debt of the provincial banks. The financial centre of gravity must be brought lower so that the co-operative movement in this province may not balance itself precariously upon its head, but may stand squarely and firmly upon its feet."

Nearly 70 per cent. of the loans advanced were for agricultural purposes such as purchase of cattle, seed, etc.

There are 35 societies for purposes other than credit. An arrangement is being made under which the audit of these societies will in future be carried out by members of the agricultural department trained in the work by the Registrar of Co-operative Societies. It is hoped that such an arrangement will facilitate the work of the societies and will provide for a true estimate of their progress.

The hiring out of agricultural implements and sale of manures proved a profitable undertaking to all the four societies formed for the purpose. The seed unions, of which there are 28 in the province, made satisfactory progress, and one of them made a profit of Rs. 1,000 by sale of nearly 8,000 lb. of good *roseum* cotton seed. On the whole they were very useful in distribution of seed, manure, etc.

There are two cattle-breeding societies—one at Nawagaon and the other at Khandwa in Raipur district. Both these have done well and are producing an improved strain.

United Provinces. The number of agricultural societies rose from 2,873 to 3,186, membership from 92,040 to 92,198, working capital from Rs. 48,61,522 to Rs. 51,90,778 and profit from Rs. 2,00,358 to Rs. 2,01,175. The increase in the number of societies compares unfavourably with that of members, but it is chiefly due to the formation of smaller organizations than those dissolved during the year. The average working capital per member, however, rose from Rs. 52·8 to Rs. 56·9. The major portion of the loans advanced were for productive purposes.

The non-credit societies for production and sale comprise five *ghee* societies and three dairies. The *ghee* societies are practically in a moribund state and some of them will probably have to be closed.

Assam. The number of agricultural societies rose from 313 to 333 and the working capital from Rs. 4,59,774 to Rs. 5,04,616, but the membership fell from 15,950 to 11,465. The average working capital available per head was only Rs. 44. There are no agricultural societies for purposes other than credit.

Co-operative Dairies.

There are now 22 co-operative milk societies in Bengal, and all except the one at Dacca have made satisfactory progress. Those in the vicinity of Calcutta are opening stalls in the markets and are coming to be realized as of great importance in connection with the supply of pure milk to the city. The expenses of management appear to be high, but the experiments made in motor transport were necessarily costly. It is reported that the societies spare no expense or trouble to ensure the purity of the milk supplied by them.

The milk society started last year in the Punjab proved a failure owing to the selfishness of its president, but another has been formed at Behrampur near Gurdaspur and has made a good start with a profit of about Rs. 200 per month. Four neighbouring Gujar villages are now anxious to combine and form into societies for sale of milk.

There are ten dairy societies in Bombay but it has been found difficult to carry on these societies at a profit. The turnover is small and the margin of profit insufficient to cover expenses. Until the whole industry can be put on an economic basis, there seems to be little hope of attaining any marked success in dairying such as is usually carried on by these societies. The Registrar, however, reports that a fresh attempt to organize the collection of milk in villages, its joint transport to cities and retail sale on a larger scale will be made next year at a few selected centres.

In Bihar and Orissa, the only co-operative organization for the supply of milk is the Mayagunj Goala Society in Bhagalpur. With a working capital of Rs. 3,134, it made a small profit of Rs. 150 during the year. The difficulty of conducting a society of this type within municipal limits appear to be the chief obstacle to success.

In Nagpur, the two co-operative credit societies of Goalas continued to work successfully in connection with the Telinkheri dairy, and made a profit of about Rs. 6,527. On account of the enormous rise in the cost of oil-cakes and other concentrated feeding stuffs, it will perhaps be necessary to pay more to the

Goalas for their milk and to raise the prices of the dairy products proportionately. During the year under report the dairy sold 357,842 lb. of milk, 1,026 lb. of cream, 4,096 lb. of butter and 771 lb. of *ghee*.

There are three co-operative dairies in the United Provinces of which one—the Barafkhana Co-operative Dairy, Lucknow—has practically proved a failure. A large amount of the outstandings is overdue and will probably prove to be irrecoverable. The other two—the Katra Co-operative Dairy, Allahabad, and the Benares Dairy—worked fairly well during the year. The former made a profit of Rs. 1,108 and the latter cleared off the losses of the previous year and made a small profit.

Cattle Insurance.

In Burma, cattle insurance was in a state of stagnation during the year. It is still restricted to five districts only. Seven new societies were registered during the year, but the total number of cattle insured fell from 7,814 to 5,988. The mortality among these cattle rose from 180 to 249, and claims amounting to Rs. 5,074 were paid, as against Rs. 3,643 paid during the preceding year. The funds of the societies, however, continued to increase and stood at Rs. 27,889 at the end of the year, as compared with Rs. 17,439 at the end of 1917-18. The funds of the Central Re-insurance Society also continued to increase notwithstanding decrease in the number of premia received, some reductions of the rates and the increase of indemnities paid by over 75 per cent.

In the United Provinces, the number of cattle insurance societies fell from four to one and that also is not in a prosperous condition.

No progress has been made with cattle insurance societies in Bombay during the year. There are 76 cattle insured for Rs. 4,955 by four societies and no society has yet failed to pay up indemnities on death.

The only cattle insurance society in Bengal has had no transactions during the year and will have to be wound up. A scheme for Naogaon, which may prove important, has, however, been drawn up.

In the Punjab, there are now eight societies, seven of which are in Rohtak and one at Madar in Jullundur. Out of 372 cattle insured, there have been only three casualties. It is reported that seven more societies in Rohtak are nearly ready for registration and a re-insurance union is in sight.

CHAPTER V.

PROGRESS IN AGRICULTURAL EDUCATION.

The necessity for agricultural education as a basis for a more rapid development of agriculture in India has always been recognized, and the recommendations made by the Board of Agriculture at Poona for the establishment, as an experimental measure, of a limited number of agricultural middle schools to meet the demand for improved rural education has received serious attention in the provinces. A great impetus has been given to the cause of agricultural education by the distribution of an Imperial allotment for the purpose, and as it is hoped there will be an annual allotment of varying amounts, the outlook is bright.

With regard to higher agricultural education, besides the Agricultural Research Institute and College at Pusa under the Imperial Department which deals with post-graduate courses, there are agricultural colleges in the provinces of Bombay, Madras, the United Provinces, the Punjab, the Central Provinces and Bihar and Orissa. At present Burman students are sent to the agricultural college at Poona for training, but the arrangement has not proved satisfactory and the necessity for a college and research institute in Burma has been recognized. Necessary plans and estimates have been prepared and sanction to an expenditure of Rs. 11,65,000 has been accorded. Bengal also is considering the question of having its own agricultural college. With the establishment of a college in Bengal, the needs of Assam will be practically met, as those of the North-West Frontier Province are now met by the college at Lyallpur in the Punjab. The subject of higher agricultural education has also received consideration at the hands of the Calcutta University Commission, and it is gratifying to note that they have advocated the introduction of agricultural courses in the University. Briefly, they recommend that (1) there should be an elementary agricultural course provided in some of the intermediate colleges suitable for zemindars, officers of co-operative

societies, district boards, teachers in rural schools, etc., and (2) facilities should be afforded in the University for the training of a more scientific and elaborate nature of a limited number of students.

The principal educational activities of the year under report are reviewed below.

The **agricultural college at Poona** which is affiliated to the University of Bombay is steadily increasing in popularity. The number of students taking the graduate course in it now stands at 144, against 135 last year, besides 38 special post-graduate students. Thirty-one students took the B.Ag. degree this year, and the demand for them outstripped the supply. Another gratifying feature is that an increasing number of graduates now prefer to go back to the land and manage their own farms.

The one-year short course in agriculture for farmers' sons, which was opened in 1909, but had been suspended during the war, was re-established. Twenty-three students attended this course.

The other **college** which gives a University course is that **at Lyallpur** which is affiliated to the Punjab University. A steady increase in the number of applications for admission to the college marks its popularity. Out of 265 applicants, of whom 173 were agriculturists, 56 students (47 agriculturists and 9 non-agriculturists) were admitted during the year. The college is now attracting better material than matriculates. Several of the students admitted during 1919 have passed the F.A. or F.Sc. and one is a B.A. Another important feature of the college is that it is attracting the sons and relatives of Indian Chiefs also, of whom there are eight in residence. Four students passed the old diploma examination. Of the 16 students who appeared for the first time in the University F.Sc. examination, 12 were declared successful, 2 being in the first class. The syllabus for the B.Sc. in Agriculture has been fixed. It is noteworthy in that only two main subjects are required for the degree, instead of three, thus enabling the college to aim at a high standard in agriculture and one science only—a good arrangement in the case of a student who wishes to proceed further with chemistry or botany.

The rural economy class for revenue and irrigation officers, which was in abeyance last year, re-opened with 13 students of whom five were Extra Assistant Commissioners. The teachers' class started last year was very successful and 20 more men were enrolled during the year.

The number of applicants for admission to the **agricultural college at Coimbatore** showed no diminution. Out of the lot, 54 students were eventually selected for admission, but only 34 actually joined. Their quality, however, is poor and the Director reports that " there is little chance that any of the present class of students will ever be fit for the higher posts of the department, and it is clear that an agricultural career offers little attraction to the youth of the country." All the 12 students who sat for the diploma examination passed. The results of the certificate examination pointedly indicate the general lowering of the standard. Out of 29 examinees, 21 passed of whom only 13 have since been selected for the higher (diploma) course.

The estate writers' course devised to give some training in the diagnosis and treatment of various pests and diseases of rubber, was held again and was as popular as before.

Two courses of instruction are given in the **agricultural college at Cawnpore**: the higher or the L.Ag. course of four years and the lower or the vernacular course of two years. The admissions for the session 1919-20 are satisfactory inasmuch as they clearly indicate that the college is increasing in popularity amongst the landowning class and the agriculturists. Out of a class of 20 in the first year of the higher course, there are 12 boys of the landowning class who represent a revenue of Rs. 2,20,475 and who, on completion of the course, intend to take up agriculture and the management of their own estates. The revenue represented by the 22 students admitted in the first year class of the vernacular course is Rs. 28,398 and at least some of them may be reasonably expected to return to the land. Many of the applicants who seek admission to this course are, however, reported to be more suitable for agricultural middle schools, and it is hoped that a number of them will be taken off by such schools when opened.

The curriculum of the **agricultural college at Nagpur** has been slightly changed. The courses of training now given at the college are:—

(1) the diploma or two-year course, and
(2) the L.Ag. or the four-year course.

The first part of the L.Ag. course is the same as that of the diploma—a course of theoretical and practical agriculture with training in subjects allied to farming. At the end of the first year, in which a course of English also is included, students are passed on to the second year, in two grades, in order of merit. Both grades take the same agricultural and subsidiary subjects, but students in grade (*i*) are given courses in physics, botany, anatomy and physiology, while those in grade (*ii*) are taught subjects of a more practical character such as carpentry and smithy. Both grades appear for the diploma examination and only those students who pass in the first division are allowed to take up the second part of the advanced or the L.Ag. course. The Director, however, is of opinion that to strengthen the L.Ag. course, it may eventually be found necessary to separate students who are studying for the two-year diploma course, still more markedly than at present, from those who intend to take up the longer and the more scientific L.Ag. course. Of 23 students who appeared for the diploma, 9 passed in the first division and 12 in the second division. Ten students sat for the L.Ag. examination, of whom 7 passed. The results were not quite satisfactory probably because of the influenza epidemic which brought the work of the college to a standstill for a time.

The college has appreciated the necessity of giving to students a sound training in dairying and dairy farming and, as it has a well-equipped dairy farm under skilled management, has arranged for a dairy diploma course of two and a half years as well as for a short, six months' course. The diploma course will cover agriculture and allied sciences necessary for dairy farming as well as full instruction in dairy farm management and dairy technique. The entrance standard for the course is the University Matriculation or the School Final Leaving Certificate. Students who secure the college diploma will find themselves fit to take the National Diploma in Dairying (I)

examination, if they desire to do so. The short course is designed to give a sound practical knowledge of dairy farm management and technique. The standard of entrance for this course is a good knowledge of English and arithmetic.

The **agricultural college at Sabour** in Bihar and Orissa now deals with a 2-year certificate course. Twelve students sat for the certificate examination held in March, 1919, of whom 9 passed. At the beginning of the session 1919-20, the total number of students in the college was 63, *viz.*, 40 in the first year class and 23 in the second year class. Of these students, only 16 belonged to the province of Bihar and Orissa, while 41 came from Bengal and 6 from Assam. The outlook for this institution, if Bengal gets its own college, is distinctly gloomy.

Higher education in agriculture and its allied sciences is provided for **at Pusa** where post-graduate courses are given. During the year under report, one student in agricultural chemistry, two in mycology, two in entomology, and one each in agricultural bacteriology and in general agriculture were under training. Besides these, one student was admitted to the bacteriological section for training in laboratory technique in connection with silkworm diseases and another to the agricultural section for a course of six months' practical agriculture on the farm, while four students were given short courses in sericulture and two in lac-culture. The question of a revision of the post-graduate courses at Pusa with a view to raise the level of training to the same standard as that in England is under consideration.

Two **agricultural middle schools** have been opened—one on the Powarkhera experimental farm in Hoshangabad and another on the Chandkhuri experimental farm in Raipur in the Central Provinces. The opening of four more schools has been sanctioned. The boys admitted to these schools are sons of substantial landowners and are expected to take up the 2-year diploma course of the agricultural college later on. A good liberal education is so combined with a series of lessons on Nature study and a hand-and-eye training in the practice and principles of agriculture as to stimulate real interest in every phase of farm work. A special reader entitled "Lessons on

Indian Agriculture" has been prepared and is being published in English, Hindi, and Marathi. Another book written for use in these schools is now in the press.

Arrangements have been made to establish two agricultural middle schools, one at Dacca and the other at Chinsura, where the principal agricultural farms of Eastern and Western Bengal are situated. The course will, as far as possible, be framed in such a way as to induce no ambition in the student to desert his calling as a farmer.

A suitable site for an agricultural school has been chosen at Bulandshahr in the United Provinces with a farm of about 70 acres, irrigable from a canal. The school will be opened as soon as the construction of buildings is completed.

In the agricultural school at Hebbal in Mysore, a two-year course is imparted through the medium of English and the students who pass through the course get a school leaving certificate. A small library, a veterinary hospital, smithy and carpentry shops and a hostel are attached to the school. Two scholarships of Rs. 15 each are awarded by Government to the best students in their respective classes. The year opened with 38 students on the rolls. Thirteen candidates sat for the final examination, of whom twelve passed. The students conducted a night school for the farm coolies.

The agricultural school at Chikkanahalli (Mysore) deals with a **vernacular course.** A farm, an implement depôt, a smithy and a carpenter's shop are attached to the school, and a free library will shortly be added to it. Admission is limited to 15 students all of whom get scholarships from Government. That the school is gaining in popularity is apparent from the fact that over 100 applications were received for admission. Ten students sat for the final examination and all were declared eligible for certificates.

During the year, one new vernacular agricultural school was opened at Veshir in the Kolaba district in Bombay by taking over the buildings and equipments of Sardar Bivalkar's school there. There are now, therefore, five such schools, four in the Presidency proper and one in Sind. In addition, four new schools will shortly be opened at Godhra (Panch Mahals),

Nippad (Nasik), Bagalkot (Bijapur), and Karad (Satara) with the help of a special grant of Rs. 1,20,000 from the Government of India towards the initial expenditure. That a genuine demand for this type of schools has sprung up will be apparent from the remarks of the Director of Agriculture which we quote below :—

"There is constant repetition, wherever I go, of the demand for more schools of the type. I have been only recently approached by deputations from four or five more districts for such schools, and I sincerely hope that further developments will be possible soon. The biggest trouble is to get good and suitable teachers and we have accordingly made provision for training teachers for the work at Loni, the original and largest school."

All the existing schools are working satisfactorily except the one in Sind, where the number of boys tends to diminish. Obviously it does not quite fulfil the wants of the people and a scheme for its development on modified lines is under consideration. With a view to provide for regular inspection of these schools, the appointment of an Inspector of Agricultural Schools has been created whose duties will also be to help in organizing new schools of this type.

A vernacular class is also held at Lyallpur to which thirty-two students were admitted during the year. A text-book on "Punjab Agriculture" and four courses for pupils in vernacular schools are under preparation.

The American Baptist Mission have proposed to open a vernacular agricultural school at Pyinmana in Burma. The question is now under the consideration of the Local Government.

The farm schools opened at Palur, Anakapalle and Coimbatore in Madras were maintained. The principal feature of these schools is that half the boys' time is spent in the schools and the other half at ordinary farm work for which they are paid. The schools have so far worked successfully.

In Bihar and Orissa, seven students joined the short courses attached to the Sabour college and eleven cultivators were under training on the department's experimental farms.

In Assam, the department trains apprentices at the government farms who are ultimately appointed as demonstrators,

The training lasts two years and is thoroughly practical. At present there are 15 such apprentices under training.

As regards **general education in subjects bearing on agriculture,** Nature study and study of plant life have formed a part of the curriculum in Guru Training Schools and some progress has been made in these branches of study in almost all middle schools in Bihar and Orissa.

In Mysore, elementary science continued to be taught in three rural schools with the object of improving instruction by giving it a distinctly agricultural bias. The Director reports that "though the result of the experiment has been, on the whole, encouraging, it must be admitted that it has not yet had a sufficiently extended trial to admit of definite conclusions being drawn."

CHAPTER VI.

PROGRESS IN VETERINARY WORK.

The statements on pages 169 and 170 give, in tabular form, details of the work of the year. The work done by the various Provincial Civil Veterinary Departments and the Imperial Bacteriological Laboratory at Muktesar is reviewed in detail below under the following main heads :—

1. Administrative changes and incidence of cattle disease.
2. Preventive inoculation and legislation.
3. Cattle-breeding.
4. Sheep-breeding.
5. Veterinary education.
6. Veterinary research.

Besides these, horse-breeding operations are carried on on a small scale in non-selected districts, the operations in selected districts being entrusted to the Army Remount Department.

In spite of great disabilities, such as shortage of staff, considerable progress has been made in several provinces. A large number of dispensaries are doing good work, and contagious disease is receiving greater and more efficient attention. The present constitution and organization of the Civil Veterinary Department are, however, inadequate to cope with the work demanded of it. In a small cadre of 37 class (*i*) appointments (excluding the special appointments attached to the Imperial Bacteriological Laboratory, Muktesar) there were 9 vacancies and 7 officers were in military employ during the year. It is, therefore, absolutely necessary to fill up the vacancies without delay and to expand the provincial departments in accordance with their relative advancement and scope of work. Some of the provinces are still lacking in an adequate number of veterinary dispensaries.

A sectional meeting of civil veterinary officers was held at Lahore in March 1919, at which several matters of importance, such as the necessity for reorganization of the Civil Veterinary

Department, the prevention of contagious animal diseases in India, veterinary education, veterinary research, etc., were discussed. The meeting was attended by 19 members and 8 visitors, and was very successful. A detailed report of the proceedings has since been published.

The standing Surra Committee met twice during the year. As recommended by them, arrangements have been made for the provision of suitable stables on *dâk* routes, and some experiments on fly repellents have been carried out by Mr. Howlett, Imperial Pathological Entomologist. These experiments, as well as those on the efficacy of drug treatment conducted by Mr. Branford at Hissar, will be continued. The possibility of a fly survey, the necessity for improving the existing arrangements for reporting cases of contagious animal diseases of all kinds and the extension of the Glanders and Farcy Act to include camels, are under the consideration of the Government of India.

1. ADMINISTRATIVE CHANGES AND INCIDENCE OF CATTLE DISEASE.

Bombay. During the year the department was placed under the direct control of the Local Government. The Director of Agriculture is, therefore, no longer responsible for its administration. The administrative charge was held by Mr. G. Taylor for about eight months—April to December 1918, and by Lieutenant-Colonel G. K. Walker, C.I.E., O.B.E., for the remaining period of the year. Major K. Hewlett held the office of Principal of the Veterinary College and continued to perform military duty in addition to his civil duties throughout the year under report. Out of the subordinate staff of 93 men, 5 were on military duty and 13 posts remained vacant.

The total mortality recorded this year under contagious diseases was 10,550 against 21,137 last year. There was a marked decrease in the mortality from rinderpest and hæmorrhagic septicæmia which may be attributed to the scanty rainfall. Among equines, there were 149 deaths from surra against 230 in the preceding year.

Madras. Mr. F. Ware held charge of the office of Superintendent and Mr. D. A. D. Aitchison that of the Principal of the Veterinary College. The number of deputy superin-

tendents was increased from two to four and that of inspectors from 14 to 16. One hundred and twenty-four veterinary assistants were employed during the year, of whom 7 were deputed to work in other departments. New dispensaries were opened at Devakottai, Pollachi, Cuddapah and Bezwada, while the Zemindar of Kangundi opened a private hospital at Kuppam which, at his request, was regularly inspected by the officers of the department. There was a considerable decrease in the number of deaths from anthrax, hæmorrhagic septicæmia and black quarter, but the continued increase in the number of deaths from rinderpest more than counterbalanced this and the total mortality from contagious diseases, *viz.*, 76,114, exceeded that of the previous year by over 6,000. Only 10 cases of surra were confirmed as against 39 of the previous year. About 4,919 cattle and 2,413 sheep and goats were passed from the Cattle Quarantine Depôt, Tuticorin, for shipment to Colombo, against 4,952 cattle and 67,664 sheep and goats passed last year. The Madras Cattle Diseases Act, which was in force in the Nilgiris throughout the year, enabled the department to stamp out successfully several outbreaks of rinderpest there in a very short time. Equally successful results were obtained during the outbreak of the disease at Kodaikanal. But a severe outbreak involving the loss of most of the valuable Australian and half-bred cattle occurred at the Coimbatore Agricultural Farm in the early part of the year and carried off 55 animals valued at about Rs. 5,000. It has since been decided that Government cattle on agricultural farms, jails, etc., should, in future, be inoculated by the " serum simultaneous " method to make them permanently immune to the ravages of rinderpest.

Bengal. Lieutenant-Colonel A. Smith held charge of the department in addition to his own duties as Principal of the Bengal Veterinary College. The number of veterinary assistants doing military work during the year was seven. There was a considerable decrease in the number of deaths from contagious diseases, the total mortality being 15,569 as against 26,486 in the preceding year.

Although there was a remarkable fall in the death rate from hæmorrhagic septicæmia, black quarter and foot-and-mouth

disease, the most striking decrease was under rinderpest, the recorded number being 10,772 against 21,126 in the previous year.

The veterinary stores at Siliguri, Bankura, Satkhira and Chuadanga were recognized as dispensaries, thus bringing the total number of such institutions to 31.

Bihar and Orissa. Mr. D. Quinlan was in charge of the department. One deputy superintendent was temporarily appointed and 12 new graduates were added to the strength of the subordinate staff, but the increase was hardly appreciable as several assistants were on leave and their places could not be filled for want of a leave reserve. There was a decrease in the number of outbreaks of contagious diseases, and on the whole the year might be considered as a healthy one in most districts. Considerable difficulties in carrying out inoculations were experienced in some of the districts, especially Ranchi. In this connection Mr. Quinlan reports that " the fact that district officers are now so taken up with their other duties and the more or less impossibility of ever being able to give even occasional personal attention to this work, makes the carrying out of this important duty of the veterinary assistants a very difficult problem. The work will have to depend in the future entirely on the staff, and until this is increased all round, but especially in its superintending officers, very little can be done to combat preventible diseases." The scheme for the inoculation of cattle in Chota Nagpur through the agency of a special staff of locally trained inoculators was further revised. As a result of this revision of the scheme, only 5 inoculators (against 14) are now employed and the staff is placed under the charge of an inspector. In Orissa, hospitals and quarters for veterinary assistants are badly needed but the resources of the local bodies are very meagre and it is expected that the Local Government will arrange to allot funds to meet a part of the cost. Most of the district boards have agreed to appoint properly trained compounders.

United Provinces. Mr. E. W. Oliver remained in charge of the department and, in addition to his own duties, carried on the work of the Second Superintendent who continued to be

on military duty throughout the year. Sixteen members of the subordinate veterinary staff were also on military duty. The appointment of a farm manager was created during the year. The functions of the department, in so far as horse-breeding is concerned, are confined to the improvement of the indigenous horse and pony for general utility purposes in tracts other than the selected districts of Aligarh, Muzaffarnagar, Bulandshahr and Meerut. The tracts are now producing a very good type of animal which may be expected to still further improve. The reported mortality from contagious diseases was 16,233 against 17,407 in the preceding year. Rinderpest, as usual, was the most serious and accounted for 11,821 deaths. There was a considerable fall in the death rates from hæmorrhagic septicæmia, anthrax, black quarter, foot-and-mouth disease and surra. Five new dispensaries were opened during the year.

Punjab. Colonel J. Farmer held the post of Chief Superintendent. Colonel H. T. Pease remained as Principal of the college throughout the year but retired in July 1919, when his place was filled by Colonel Walker. Colonel Pease's retirement from the post of Principal which he has held for some 18 years will be a great loss to the college, the present high reputation of which is largely attributable to the excellent and whole-hearted work of Colonel Pease. The staff was even more depleted than in the previous year. There were 46 veterinary inspectors and veterinary assistants below strength in a total subordinate cadre of 208, out of which 37 were on military duty. Contagious cattle diseases accounted for 28,794 deaths compared with 30,325 in the preceding year. Over 70 per cent. of the mortality was attributable to rinderpest which was prevalent throughout the province and was aggravated by the scarcity of fodder. Surra was not so widespread as last year. It accounted for only 70 deaths as against 1,362 in the previous year. The mortality due to other diseases also was below the normal, probably on account of the dry character of the year.

Burma. Two superintendents have been on military service, and for the greater part of the year Colonel G. H. Evans has run the department single-handed. One inspector and three assistants were loaned to the Army Veterinary Department and two inspectors were on duty with the Chin

Hills expedition. An increase in the staff of 6 inspectors and 29 veterinary assistants was sanctioned during the course of the year and a further increase of 3 deputy superintendents, 1 inspector and 23 assistants has been sanctioned since the close of the year. A larger measure of supervision over the staff of veterinary assistants is, however, necessary. A severe outbreak of rinderpest in several Lower Burma districts and in Katha in Upper Burma accounted for some 25,000 out of the 30,451 deaths from contagious diseases reported during the year. Inoculation was practised extensively in checking the disease. No less than 64,824 injections were made during the year as compared with 12,807 last year. Excellent rules have been framed for the prevention of these diseases, and in some districts the rules are well observed, but their evasion by a few cattle-owners largely nullifies the good effects. There is the usual complaint that the offenders come largely from the ranks of cattle-owners in the neighbourhood of Rangoon and other towns who breed large herds for the sale of milk. The matter has been recently investigated by the Stock-breeding Committee whose recommendations are under the consideration of the Local Government.

Central Provinces. Mr. C. W. Wilson remained in charge of the department which is still hampered by the absence of a Second Superintendent, but it is hoped that the appointment will soon be filled. A deputy superintendent was appointed for the Chhattisgarh division to secure adequate inspection of the many scattered dispensaries in the division. The strength of veterinary assistants at the close of the year was 121. Three veterinary inspectors and one veterinary assistant continued to be on military duty. The number of deaths from contagious diseases was 21,344 against 24,380 in the previous year. Rinderpest was very prevalent, but in a mild form in most of the districts. Inoculation was quite effective and reduced the mortality to 0·024 per cent. Anthrax existed in a sporadic form but did not do much damage. Surra also was less severe and levied a lighter toll of 264 only against 542 in the previous year. A case of surra was confirmed in a dog at Seoni—a factor which will have to be reckoned with in tracing the origin of outbreaks. Mr. Wilson reports that "in the course of an

investigation of surra in Khurai tahsil, it has been well-established that bovines succumb to surra alone and that surra parasites are seldom detected in blood after death of typical subjects." A disease simulating feline typhus again made its appearance in the Akola district and in the Ellichpur sub-division, but it came to notice too late for any investigation to be made.

Assam. Mr. W. Harris continued to hold charge of the department. Four veterinary assistants remained on military duty. There was a general decrease in the mortality from contagious diseases and it was specially low amongst bovines. Out of the total mortality of 20,819 against 47,932 of the preceding year, rinderpest accounted for 7,239 against 29,808, and anthrax for 1,190 against 2,748, during 1917-18. There were 10 deaths from surra against 13 in the previous year. In the Manipur State surra broke out in 49 Government mules imported from Burma in connection with the Kuki punitive measures. When four deaths had occurred, the disease was microscopically confirmed and the remaining animals were found suffering from surra. They were shot and the disease was prevented from spreading. The department experienced considerable difficulties in finding suitable assistants for the higher and more responsible posts. The Superintendent reports that the intellectual standard of the majority of veterinary assistants in the province is low and only a few show any natural aptitude for the work. A better class of man can not, however, be reasonably expected to take up veterinary work unless the pay and prospects of service are adequately improved.

North-West Frontier Province. Mr. T. F. Quirke held charge of the department in addition to the charge of the North Punjab. There are 3 inspectors and 17 veterinary assistants. The staff was below the sanctioned strength on account of 7 veterinary assistants being away on military duty. During the year, 31,293 cases of contagious diseases were reported, of which 7,224 proved fatal, compared with 25,247 cases and 2,904 deaths in the preceding year. Sixty-six cases of surra occurred during the year. The staff made village to village tours in-

structing zemindars on preventive measures against the disease, and copies of a pamphlet in Pushtu containing necessary instructions on the subject were freely distributed. The necessity of making provision of proper stabling accommodation on all *dák* routes, as advised by the members of the Surra Conference, has been recommended, and its adoption is expected to have beneficial effects in checking the spread of the disease. Rinderpest accounted for a large percentage of the mortality amongst the bovines. Much headway has, however, been made in popularizing inoculation work in the villages where the people now readily bring forward their animals for inoculation when disease is prevalent. A larger number of veterinary assistants is, however, required for district work.

Sind, Baluchistan and Rajputana. Mr. J. G. Cattell held the post of Superintendent except for about three months when Khan Bahadur S. G. Haji, Deputy Superintendent, acted for him. He acted as veterinary officer of the Army Remount Department, Baluchistan Circle, until the 4th December, 1918, in addition to his own duties. The administration of the Civil Veterinary Department in Sind, Baluchistan and Rajputana by one superintendent is practically impossible, and it is therefore desirable to strengthen the supervising staff as early as possible.

Sind.—The subordinate staff consisted of 16 veterinary assistants. The total mortality from contagious diseases was 4,125 against 5,686 in the previous year. The statistics, however, are not quite reliable. The distribution of service post cards to selected zemindars, etc., to send reports of diseases has not met with much success, but it is satisfactory to note that the number of outbreaks reported direct by stock owners is increasing. Surra among equines was less prevalent and was responsible for 44 deaths only against 258 in the preceding year. Twenty-nine camels also succumbed to the disease in Karachi, Thar and Parkar and Larkana districts. The figures do not, however, give any reliable indication of the extent to which the disease was prevalent among these animals as statistics relating to them are seldom reported. In a microscopical examination of the blood of about 1,500 camels showing no symptoms of surra, one per cent. was found to be affected with the disease.

Foot-and-mouth disease was very widespread and carried off 387 animals out of 12,714 attacked. A new dispensary was opened during the year but the opening of 5 more had to be postponed owing to the impossibility of obtaining the services of veterinary assistants. A serum pit at the dispensary at Sijawal was completed during the year.

Baluchistan.—Five veterinary assistants were working during the year. The total mortality from contagious diseases was 6,442 against 9,286 in the previous year. They were most prevalent amongst sheep and goats.

Ajmer-Merwara.—The total mortality reported from contagious diseases was 128 against 112 in the previous year. Very little reliance can, however, be placed on the mortality statistics.

Imperial Bacteriological Laboratory, Muktesar. Mr. A. L. Sheather held the office of Director and First Bacteriologist. Mr. A. W. Shilston remained as Second Bacteriologist till 6th July, 1919, when he succumbed to an attack of acute glanders. By his death, which can be considered nothing less than a tragedy, veterinary science in India has lost one of its most promising and valuable workers. His energies were devoted to problems connected mainly with rinderpest, surra and dourine, and much valuable work in these subjects stands to his credit.

In spite of difficulties connected with the electric centrifuges, scarcity of labour, etc., the output of the products of the laboratory increased from 2,698,711 doses in the preceding year to 3,750,396 doses in the year under review. The branch laboratory at Kurgaina (Bareilly) was opened for the winter months for the preparation of anti-rinderpest serum and to maintain the rinderpest virus for use in the inoculation of animals at the various military dairies. The necessity of getting the new laboratory buildings at Izatnagar completed as early as possible is a pressing one, as otherwise it will be impossible to meet the increasing demands for anti-rinderpest serum.

The following table compares the amounts of the principal products of the laboratory—sera and vaccines—manufactured

and issued during the year 1918-19 with the average amounts of the preceding quinquennium :—

Name of product	Doses prepared		Doses issued	
	1918-19	Average of previous 5 years	1918-19	Average of previous 5 years
Rinderpest serum	3,213,043	1,337,214	3,259,616	1,315,832
Anthrax serum	46,368	23,927	36,552	27,622
Hæmorrhagic Septicæmia serum	155,135	120,399	132,046	113,553
Hæmorrhagic Septicæmia vaccine	125,355	146,165	125,355	146,165
Black Quarter vaccine	45,000	10,000	19,176	18,005
Mallein	143,346	60,235	160,091	59,429

The total value of the different products, calculated on the basis fixed by Government, amounted to Rs. 4,80,732-13-9 against an expenditure of Rs. 4,37,712-13-4.

During the year one laboratory assistant from Bengal and a veterinary assistant from Bihar and Orissa underwent a course of training at the laboratory.

2. Preventive inoculation and legislation.

In India, the carrying out of preventive inoculation in a thorough and an effective manner is by no means an easy task. The agencies entrusted with the reporting of outbreaks of contagious diseases are irresponsible and dilatory, and seldom, if ever, send in reports promptly and accurately. The inevitable result is that, in most cases, preventive measures follow on the heels of outbreaks and fail to meet them face to face. There is still much apathy and prejudice against inoculation of cattle. The people are ignorant of the ordinary precautions and require a good deal of persuasion to produce their cattle for treatment. There is practically no restriction on the movement of cattle from infected areas and there is no legislation enjoining compulsory inoculation. Above all, the supervising as well as the subordinate staffs of the department are quite inadequate for the task. In spite of all these difficulties, satisfactory results,

as shown in the statement given below, were achieved during the year under review :—

Disease	Number of outbreaks in which inoculation was undertaken	Deaths uninoculated	Inoculations made	Deaths after inoculation	Percentage of deaths in inoculated animals
Rinderpest	4,794	75,186	619,199	2,641	0·42
Hæmorrhagic Septicæmia . .	594	3,306	116,960	83	0·07
Anthrax	94	1,687	13,684	14	0·09
Black Quarter	190	178	16,440	15	0·09

As regards rinderpest, which exacts the heaviest toll on cattle in India, the " serum alone " method of inoculation is now followed generally on account of its simplicity and absolute safety. It means an injection of a suitable dose of serum calculated in accordance with the body weight and susceptibility of the animal and reinjection several times during the course of an epidemic. It does not give full protection for an unlimited length of time and has several limitations. The method, used without powers of compulsory inoculation and isolation, although capable of reducing the death rate considerably, is not, therefore, efficient enough for stamping out the disease. The " serum simultaneous " method, which means an injection of virulent blood simultaneously with the serum and gives a permanent immunity to the animal, has given excellent results in military dairies and in the herd of cattle at the Agricultural Research Institute, Pusa. During the winter 1918-19, 40 pure-bred imported animals were treated by this method but of which 6 died, but in no case was rinderpest directly responsible for death; 438 cross-breds were inoculated, with 6 deaths; 382 buffaloes, with one death, and 649 country animals without a single death. The percentage mortality among the total of 1,509 animals, treated by the method, was 0·86, or, excluding the pure-bred imported stock, only 0·47. This method, however, requires a closer expert supervision and cannot, therefore, be adopted more generally till an adequate and a sufficiently trained staff is available.

As regards prophylactic inoculation against hæmorrhagic septicæmia, the vaccine and serum treatment, when employed correctly and in time, has been found to be very valuable. The best testimony of its efficacy is the readiness of cattle-owners, in some instances, to pay charges. A small beginning in this direction has been made in Bombay. The time must come for treatment of all kinds to be paid for directly, and not indirectly, as at present.

Anthrax is a disease not easily diagnosed by laymen, and at the beginning of an outbreak, is often wrongly reported; while, owing to the nature of the malady, its sudden onset and rapidly fatal termination, it is only in a few cases that veterinary assistants are able to reach the seat of trouble in time to be of much assistance. Prophylactic measures, when taken in time, yield very satisfactory results in this disease as well as in black quarter.

With regard to the influence of preventive measures on the incidence of contagious diseases, Col. Farmer remarks :—

"We can only judge this by careful enquiry on the field and from that we learn that where anti-inoculation can be carried out under circumstances essential to its successful application, the results are very beneficial. There is no doubt, however, that much serum is used with a minimum of advantage. Hitherto a certain prodigality in the use of sera, etc., has been regarded as excusable from an educative point of view and although it has been controlled as far as possible, we have arrived at a stage where regard must be had primarily to the economic application of anti-inoculations. To enable the department, as the responsible agency, to do this, it must be made possible for action to be taken at the seat of an outbreak immediately after the appearance of the disease. The staff must be sufficient to allow of careful observation of results so that action may be continued and extended as may be required; there must also be sufficient supervising staff to organize the work and ensure its being thoroughly carried out."

The whole of the legal powers now possessed by the Civil Veterinary Department are contained in the Dourine Act, the Glanders and Farcy Act and the Live Stock Importation Act, supplemented, in the case of Madras, by a Cattle Diseases Act. In Burma, the diseases of cattle are dealt with under the Village Act.

The Cattle Diseases Act has proved valuable in Madras in dealing with cases of cattle disease at fairs and elsewhere. The Local Government have made a bye-law under section 18 of the Act under which District Magistrates are empowered to close temporarily all cattle markets and fairs, public or private, held in an area in which the Act is in force, whenever they consider such a course necessary to prevent the spread of a contagious disease. Much of the good which may result from the operation of the Act is, however, frustrated by the people themselves, who, in many cases, continue to hold the fairs in adjoining villages.

A proposal to make municipalities responsible for reporting to the Veterinary Department, the occurrence of contagious diseases within their jurisdiction, by adding a bye-law to the Municipalities Act, is under the consideration of the Government of Madras. Other Local Governments and Administrations also might see their way to considering the advisability of introducing similar measures in their provinces.

A slight amendment to the Dourine Act is under the consideration of the Government of India.

Although for general administrative reasons it is not yet desirable to seek legal powers to compel inoculation, some form of general legislation is necessary to deal with cattle diseases, especially as regards segregation and the movements of cattle.

3. Cattle-Breeding.

The important part played by cattle in the agricultural economy of India makes their care and improvement a matter of first rate concern. No doubt there are some good breeds of cattle, but in many cases they are rapidly losing their valuable characteristics through indiscriminate and careless methods of breeding. The breaking up of the grazing areas and scarcity of fodder have acted adversely on the maintenance of the breeds, and have offered sufficient inducement to owners of cattle to dispose of their best stock for which there is a heavy demand from other parts of India as well as from foreign countries. Thus, there is a distinct danger of extinction of some of the good breeds of cattle in India. The stock of Dhanni, Hariana

and Sahiwal breeds is no longer sufficient to meet all demands from Bengal and the United Provinces and for export. The demand for Dhanni bulls in the North Punjab has been very great and the supply has been much reduced. With a view to protect the breed, the Local Government have lately given effect to a scheme for subsidizing selected owners of this class of animal in Attock and Jhelum, and it is expected that this incentive will tend to save the breed from further depletion. Possibly one solution of the difficulty would be for Government to maintain pure bred herds of the reliable types.

The poor quality of the ordinary cattle of India is well known, and is largely due to climatic conditions, combined, to a great extent, with the ignorance and apathy peculiar to indigenous cattle-breeding, neglect, starvation, in-breeding and the usual anti-castration attitude. The first step towards improvement of this class of cattle is to ascertain whether the improvement of the local breeds is to be by rigid selection of indigenous cattle or by crossing with exotic Indian breeds such as Montgomery. Where imported bulls are used, the breeding operations must be under strict supervision and the dangers associated with cross-bred animals should be adequately safeguarded by measures such as inoculation by serum simultaneous method against rinderpest, as the disease, after passage through a highly susceptible animal of this class, attains a much higher virulence. Except in special cases where rapid milk production is required and where efficient control is established, the general importation of exotic breeds of cattle should therefore be avoided and the main policy of the department should be the improvement of indigenous breeds by selection.

The rapid extension of arable cultivation and a stricter conserving of jungles as reserves have considerably encroached on grazing areas and therefore it is all the more necessary to pay serious attention to systematic cultivation of fodder crops. During the year under review, scarcity of fodder was more or less widespread throughout the country and was responsible for the loss of a large number of cattle. In some tracts, *e.g.*, in the Ahmednagar district in the Bombay Presidency, the trouble was so acute that Government had to open central camps for

cattle of agriculturists willing to have them fed upon cactus at Government expense. They were kept in the camps for about a month and when accustomed to the diet, were returned to their owners who were given every facility and encouragement to continue using the fodder. By the end of March 1919, over 4,000 cattle subsisted mainly on cactus. Such conditions are by no means conducive to cattle-breeding and any attempt at improvement in this direction must of necessity proceed along with measures for better and surer provision of cattle feed. It follows that cattle must be bred on cultivated lands and suitable fodder crops must be raised and stored to meet famine conditions. In short, stock feeding must form an essential link in the chain of farming operations in India. But such a condition can only be brought about when it becomes economically sound for the cultivator to breed and rear cattle. The high prices which good draught and milch cattle fetch now-a-days, the demand that is springing up for Indian cattle in foreign countries, the abnormal rise in the price of all sorts of dairy produce and the need of the cultivator himself for stronger cattle, all tend to indicate the fostering of cattle-breeding on dual purpose lines, *i.e.*, dairying and draught, as the best solution of the economic problem involved. The scheme for the investigation of cattle-breeding and of the dairying industry in India, as recommended by the Board of Agriculture in India, 1916 (the initial cost of which is estimated at Rs. 2,22,000 and the net recurring expenditure at Rs. 1,68,446 per annum), has recently been sanctioned by the Secretary of State for India. In outline the scheme provides for an organization which, working on the material provided by the military dairy farms, will undertake breeding operations designed to improve the milking qualities of Indian cattle, and will at the same time inaugurate systematic education in dairying by opening dairy schools. The whole question, including animal nutrition problems, will now receive due attention from an imperial point of view. The scheme is not, however, intended to limit provincial activity in the field of cattle-breeding and dairying, but has as its object the encouragement of local effort in this direction.

We may now proceed to review the work done in the various provinces.

In *Bombay*, the scheme for issuing premium bulls mentioned in the preceding years' reports made no progress in the Deccan owing to the scarcity of fodder. In Gujarat, nine premium bulls were issued from the Northcote Cattle Farm to the Surat district and one to the Ahmedabad district. District Local Boards do not, unfortunately, appear to be in a position to do much for cattle-breeding, even where the possibilities are favourable. The number of cattle on the Northcote cattle farm at Chharodi in Ahmedabad district at the end of the year was 641 against 612 on the corresponding date last year. It is expected that there will soon be a strong local demand for cows and bullocks and that the farm will be in a position to supply a considerable number to replenish herds that have been depleted in consequence of scarcity of fodder in the Presidency. The question of a satisfactory water supply held up the scheme for establishing a cattle farm in Dharwar district. Proposals for the establishment of such farms in the Sholapur and West Khandesh districts for the Khillari and Tapti Khillari breeds, respectively, are now under consideration, but they will probably have to await the development of the Nira right bank canal project.

In *Madras*, cattle-breeding operations are controlled by the Agricultural Department. The Deputy Director of Agriculture, Live Stock, has experienced considerable difficulty in obtaining a sufficient number of buffalo bull-calves of the stamp he needs for trials to improve the buffalo which supplies most of the *ghee* (clarified butter) and butter consumed in the Presidency. The dairy at Coimbatore was as popular as ever, and demonstrated the great opening for a creamery trade in similar localities. It was not, however, possible to do much in the way of research on account of lack of staff, although a successful attempt was made to manufacture soft cheeses.

In *Bengal*, there were two farms at work during the year—one at Kalimpong, managed by the St. Andrew's Colonial Homes, and the other at Rangpur, under the agricultural department. The herd at the former consists of Siri cattle only with the addition of a Kerry cow and three half-bred English cows. The policy pursued at the latter farm is to conduct cattle-breeding experiments in a systematic way, with the object of a general

improvement of the indigenous cattle. Improvements are already being noticed. As previously explained, the herd consists of two sections in which *deshi* and imported Hansi bulls are respectively used. The main difficulty with regard to the purely *deshi* herd lies in the supply of bulls. The pedigree of these, owing to the large amount of crossing in the villages, cannot be determined and they do not get calves true to type. The Director reports that—

"A good looking bull of desirable type, bred from a good mother, was used last year for the first time in the *deshi* herd. The resultant stock are all bad; none is true to type and all contain undesirable characteristics apparent in neither of the parents. It thus seems that in this herd a great deal of casting will be necessary before pedigree can be arrived at. On the other hand, it is expected that the necessity for casting will be, to a great extent, reduced in the case of the progeny of the Hansi bulls, which do possess fixed characters."

In *Bihar*, cattle-breeding operations are being conducted at Sipaya with the object of evolving a good type of cattle of which the first "point" should be that the males should make good working bullocks, and the second "point" that the cows should be good milkers. The herd has been built up from local cows and good bulls. There are now 99 breeding cows. Dairy herds are maintained at Sabour and at Ranchi with the object of establishing a good type of milker of pure Indian blood. It is intended to start a breeding herd of buffaloes at Netarhat as soon as funds permit.

In the *United Provinces*, there are two Government farms. One is at Manjha in the Kheri district which is famous for its breeds of cattle, *viz.*, Kherigarh and Parchar. There are at present 361 head of cattle on the farm. The breeds are not good milkers, but are strong draught animals and are much in demand in Oudh and North Bengal. The other farm is at Madhurikund in the Muttra district, and deals with another breed—a moderately large sized work cattle and a better milch cow. Experiments with crossing the *deshi* cow of good stamp with Hissar, Sahiwal and Kosi strains are in progress here and there are 262 head of cattle now. Both the farms, which have, for the last few years, been in the process of building up, are now getting into working order.

The largest cattle farm in India is that at Hissar in the *Punjab* which comprises an area of 40,000 acres, out of which 2,000 acres are set apart for cultivation of fodder crops. The total number of animals on the 31st March, 1919, was 6,006 valued at Rs. 5,08,694. A marked testimony to the excellence of the work carried out on the farm is the strong demand for its cattle by foreign Governments, the Belgian Government alone buying no fewer than 358 head during the year under review. Rs. 2,000 were offered for a bull last year. Several young bulls have been sold for Rs. 500 each and cows for Rs. 250 —400 each. Specially selected bulls are issued to the district boards in the Punjab at Rs. 200 each and are producing very good stock. Heifers under standard are weeded out and sold to zemindars, and others are auctioned. The receipts during the year amounted to Rs. 1,84,787, a record for the farm.

Cattle-breeding proceeds steadily in the districts where, at the close of the year, there were 1,265 stud bulls at work.

In the *Central Provinces*, the agricultural department is making rapid progress in cattle-breeding. There are now 8 Government cattle-breeding farms at Raigarh, Borgaon, Powarkhera, Adhartal, Nagpur, Telinkheri, Bilaspur and Drug. The primary object is to improve the breed for draught purposes. The question of improving it for milk has not yet been taken up on a large scale. From the work already carried out on the Nagpur and Telinkheri farms, it is, however, evident that by crossing the local cattle with good milch breeds it is possible to raise good dual purpose animals. The Montgomery-Gaolao cross has proved much superior to the pure Gaolao, both as a draught animal and as a milch cow. Arrangements have therefore been made to use Montgomery bulls in crossing herds of Gaolao, Khamgaon and Umardha cows. Crosses between the Ayrshire and the local breeds, although excellent dairy animals, are not as good for draught purposes as the Montgomery-Gaolao cross and are less immune to the diseases of the country.

On the Bilaspur and Drug farms, cross-breeding has been started with the object of giving size and strength to the small breed of the tracts. Malvi bulls are being used, as this breed, though much larger, is similar in many respects to the Chhattis-

garhi. It is believed that by crossing on these lines, real improvement can be effected much more quickly than by selection only. Cattle-breeding has been started on the Adhartal farm with the object of supplying stud bulls of the Malvi breed to cattle-breeders in the northern districts of this circle. All the distinct breeds of cattle found in the Central Provinces, except the Nimari and the Khargaon breeds, are now represented on one or more of the breeding farms already opened. The Khargaon closely resembles the Khamgaon breed and it does not appear necessary to take up its improvement as a separate entity. The improvement of the Nimari breed will be taken in hand on the Khandwa farm to be opened next year. Besides the Government farms, there are two co-operative cattle-breeding societies in the provinces, one at Khandwa and the other at Nawagaon, and a co-operative dairy farm at Amraoti.

In *Assam*, there is a cattle farm at Upper Shillong where Patna and cross-bred cattle are maintained, but breeding will be confined for the present to the Patna herd only. With regard to the question of improvement in the existing breeds of cattle in Assam, the Chief Commissioner has issued a resolution directing that measures should be taken for (*i*) the importation of selected sires which will be entrusted either to local bodies or to tea planters and other individuals interested in cattle-breeding and the improvement of the milk supply, (*ii*) the general education of the people by example and precept to understand the benefits of selective breeding and of proper feeding and keeping of cattle, (*iii*) the reservation of adequate grazing grounds and (*iv*) the introduction of suitable fodder crops and the devising of means for preserving grass and other fodder in the conditions in which the people live. It is also proposed to constitute local committees of persons interested in cattle-breeding with a view to supervising the working of the experiments outlined above and in educating the people.

At *Pusa*, the combined herds of pure Montgomery and Ayrshire-Montgomery totalled 372 head in the year under review. The Montgomery herd is divided into two portions.

(*a*) For selective breeding for milk production. The cows here are divided into five groups each with

a separate bull; and the object is to breed up a first class milking strain in each group and thereby establish the breed without fear of in-breeding. All the best milkers in the Montgomery herd are included in these groups.

(*b*) For crossing with the Ayrshire bulls. The cows here are not sufficiently good for inclusion under (*a*) and are used for putting to the Ayrshire bulls for the cross-bred herd.

The policy of strict selection for milk yield is being continued throughout the Montgomery milch herd, and the best records among the cows in it ranged from 4,852 lb. to 5,654 lb. The herd appears to have acclimatized itself successfully, without deterioration, in a climate which differs widely from that of the Punjab—the natural habitation of the Montgomery breed of cattle.

All Montgomery cows calving down for the first time are now being treated in English fashion, their calves being removed at birth and put on the pail. No difficulty whatever has been experienced in milking these cows without their calves.

The Montgomery-Ayrshire cross-bred herd now stands at 73 head. The heifers and cows in this herd are put to cross-bred bulls of which there are three with the herd. The Imperial Agriculturist reports that—

"At present it appears that three-quarter-breds usually have a longer, thicker coat, and are apt to be rather slower doers at first than half-breds. They, however, do quite well in the later stages. It is practically impossible now to distinguish between half-breds and quarter-breds and, as far as the experiments have gone, it appears evident that the half English blood in the half-bred bull is sufficient to produce the same English characters as regards appearance and build as the full English and it will be of interest to see if this holds good when tested at the pail. The double half-breds are in all points similar to half-breds and do equally well."

Experiments with half-bred bulls and country cows are also in progress now. The full lactation yields for the half-bred cows have been quite satisfactory.

The calf-rearing and feeding experiments indicate that half the usual quantity of milk fed to a calf during 10 months' lacta-

A BUNCH OF THREE-QUARTER AND DOUBLE CROSS CALVES.

PLATE II.

PLATE III.

AYRSHIRE × MONTGOMERY COWS OF THE PUSA HERD.

Daisy No. 5.

First lactation . . 7,534 lb.
Second lactation . . 6,958 lb. (to date.)
Due to calve in March 1920.

Alibi No. 3.

First lactation . . 8,347 lb.
Second lactation . . 8,700 lb. (to date.)
Due to calve in March 1920.

Molly No. 24.

Calved for the first time in November 1919: now giving 24 lb. a day.

tion period, if given to the calf in the first five months only, grows a bigger, better calf at a far less cost.

The usual biennial sales were held in December 1918 and April 1919, when seventy animals realized a total of Rs. 11,850. The strong demand for stock is a testimony to the popularity of these sales. In several cases Rs. 600 have been offered for young bulls.

The whole of the young stock and all bulls—English, Montgomery and half-bred—together with all cows not heavy in calf —have been successfully inoculated by the serum simultaneous method.

4. Sheep-Breeding.

In India, sheep-breeding on improved lines is beset with considerable difficulties. Except in certain favoured localities, the climatic conditions militate far too strongly against any attempt to improve fleece and mutton conjointly, as has been proved conclusively by the experiments carefully carried out at Pusa for a period extending over the last 15 years. The experiments carried on in the United Provinces, the Punjab and the North-West Frontier Province have, however, yielded encouraging results with regard to the quality and quantity of the wool, but the task of teaching the poor, conservative Indian shepherd the proper handling of sheep and wool, the method of shearing, dipping, etc., is by no means an easy one. Should the continuance of the experiments definitely prove the possibility of lasting improvement in the quality and quantity of the Indian wool, the question will, however, be worth a more serious consideration from the commercial standpoint of view.

In *Madras*, an attempt to introduce some Shropshire rams for the purpose of crossing with the ewes at Bantanahal ended, unfortunately, in complete failure. Soon after their arrival, the rams succumbed to septic pneumonia.

In the *United Provinces*, the experiments undertaken by the department have yielded encouraging results. The grading up of the Indian ewe by means of successive strains of Australian Merino blood is steadily exerting a beneficial effect on the wool as to its weight, length of staple and quality.

Although the amount of wool obtained from the Indian sheep is scarcely ever as much as 2 lb., these half-bred Merinos are now yielding 2½ lb. in the first shearing, 3½ lb. in the second shearing and when 2 years old, 5 to 10 lb. per annum. It is expected that on an average 7 to 9 lb. of wool will be obtained from a full grown sheep; that is, more than three times as much as can be obtained from the country sheep. In addition, the wool is of good type and fetches Rs. 1-6-0 per lb. when country wool is sold at R. 0-6-0 a lb. Some interest is being aroused on the subject and several private estates have intimated their intention to give the matter a trial. Experimental flocks are now established at Lucknow, Moradabad, Kheri, Bundelkhand, Etawah and Naini Tal. The original proposal to establish a sheep-breeding farm near Orai has been taken up again and it is hoped to start the farm soon.

In the *Punjab*, sheep-breeding experiments are in progress on the Hissar farm. The total number of sheep on the farm on the 31st March, 1919, amounted to 1,143 valued at Rs. 9,470. The system introduced last year of lambing all the ewes in the spring and allowing them to lamb once only during the year has been continued. The decrease in the number of lambs is compensated for by fewer casualties and improvement in quality. The ewes do better and show a tendency to produce better fleece. Rs. 3,378 were realized for wool during the year. One hundred and five three-fourth and half-bred Merino rams were sold for breeding during the year.

The experiment of Merino breeding in the Kangra district was unsuccessful on account of the carelessness of the people. The flock of Merinos at Palampur was therefore transferred to Lahul where the crosses between Merino and the Lahuli and Biangi breeds have shown an improvement in the wool, especially where the people use the rams systematically. Reports of the Cawnpore Woollen Mills on the wool are encouraging, but it will be some time before the improved wool can be produced in sufficient quantity to realize its full commercial value.

In the *North-West Frontier Province*, experiments with Merino rams are being carried out on a small scale in the Hazara district. One Pusht-i-Kuh ram was allotted to a

reliable flock master in the Peshawar district who runs over 1,000 sheep in Charsadda; two were sent to the Kurram valley and one was placed at Tarnab. In order to establish a small flock at the latter place for improving the indigenous breed, 45 ewes of the type locally called "Turki" were purchased for the Pusht-i-Kuh ram. The lambs are reported to be strong and good in fleece, and all resemble the male parent in build, colour, weight of tail, etc. They appear to mature early, which is an advantage in a breed designed to furnish both mutton and wool. The progress of the experiment of acclimatization of the Tigris ram so far appears successful and may have important results.

5. Veterinary Education.

The veterinary colleges at Bombay, Madras and Calcutta continued to give a 3-year course in English, while that at Lahore held a course of 4 years in addition to a 3-year course. Both courses are in the vernacular. The post-graduate course in the Lahore college was in abeyance during the year, but will be re-opened in November 1919. The total number of students who passed the final examinations of these colleges during the year was 142. In Burma, the veterinary school at Insein, which deals with a 3-year vernacular course, turned out 12 students, and that at Taunggyi, which imparts a one and a half years' vernacular course, 2 trained students. Difficulties in obtaining suitable candidates for admission to these colleges and schools continued to increase, and in Madras they were so acute that the rate of monthly stipends had to be increased from Rs. 10 to Rs. 15 to induce better qualified candidates to seek admission to the local college. It is, however, hoped that the improvement in the pay and prospects of the subordinate veterinary staff, which some of the Local Governments have under consideration, will result in a large number of better qualified candidates seeking admission to these colleges and schools.

The demand for veterinary graduates for employment in the various provincial departments, the Army and the Indian States continues to increase, and is not likely to be satisfied until the opening of another veterinary college in Northern

India the proposals for which have so long been held in abeyance on account of the war.

The teaching staff of the existing colleges requires strengthening by the addition of more European teachers, and it appears desirable to revise the curricula on the lines prescribed by the Royal College of Veterinary Science for the colleges in England. This will tend towards uniformity in teaching. The whole question of veterinary education in India is under consideration. An informal conference on the subject was held at Simla in September 1918, and the question was further discussed at the meeting of veterinary officers in India held at Lahore in March 1919. As a sequence of these conferences it is hoped that the lines of improvement will soon be determined and veterinary education in India put on a proper footing.

The veterinary associations started in the United Provinces and the Punjab with the object of keeping the members up to date in their scientific knowledge and of promoting an interchange of professional ideas have been doing excellent work. Other provinces also would do well to start such associations.

6. Veterinary Research.

Owing to the paucity of staff and increase in the routine and administrative duties of the officers of the department, it was not possible to devote much time to research work. The bulk of it, however, was, as usual, carried out in the Imperial Bacteriological Laboratory at Muktesar and related to the following subjects:—

Rinderpest and Hæmorrhagic septicæmia. Experiments regarding the length of time for which hides removed from animals which have died of these diseases remain infective were continued under varying atmospheric conditions.

Surra. Experimental tests in connection with this disease were continued at Muktesar. As regards treatment of surra, several members of the department obtained promising results, but on a limited scale. Those obtained by Branford at the Government Cattle Farm, Hissar, and published as an article in the "Agricultural Journal of India," Vol. XIV, Part V, October 1919, were particularly encouraging. The Imperial

Pathological Entomologist did a considerable amount of work in connection with the prevention of surra-transmission by Tabanidæ, more particularly among transport camels. Further experiments in these directions are, however, necessary to lead to more definite conclusions.

Johne's disease. Suspected materials from two cases of Johne's disease were received at the Muktesar laboratory from Bettiah (Bihar), which, on examination, yielded positive results. Fresh attempts are being made to cultivate the organism.

Tuberculosis. A number of strains of tubercle bacilli are under cultivation at Muktesar, and it is hoped that circumstances will permit of a series of inoculation experiments with cattle and buffaloes being undertaken shortly.

Parasitic worms. A new species of worm causing fatal gastritis in calves was detected by Sheather. A description of it has been published in Bulletin No. 86 of the Agricultural Research Institute, Pusa. Another parasitic worm, occurring in the larynx and pharynx of cattle and buffaloes, has been examined, and an account of it will shortly be published.

Malaria. What appears to be a case of true malaria infection in a buffalo has been discovered by Sheather, and a description of it has been published in Bulletin No. 90 of the Agricultural Research Institute, Pusa.

Prophylactic and curative effects of distemper vaccines and pneumonia phylacogen were under investigation at the Research Station at Badshahbag (U. P.). A series of experiments to determine the most economical and effective form of drug treatment for the numerous internal and external parasites of sheep and cattle were also in progress there.

The sectional meeting of veterinary officers held at Lahore in March 1919, strongly urged the necessity of having a fully equipped central research institute with an adequate staff, and of further widening the field of research both on the physiological and pathological sides. The question is an important one and is under the consideration of the Government of India.

CHAPTER VII.

PUBLICATIONS.

Imperial. The Imperial Department of Agriculture in India issued during the year six memoirs, thirteen bulletins (including three reprints and one vernacular version) and three publications of the indigo series. Ten publications were in the press at the end of the year.

The demand for the bulletin on "Insecticides, Mixtures and Recipes for use against Insects in the Field, the Orchard, the Garden and the House" continued, with the result that it had to be printed a third time. A Bengali version of Bulletin No. 46 on Beekeeping, written in language simple enough to be understood by the village folk when read by themselves or read out to them, was issued during the year and the whole edition rapidly sold out.

The "Agricultural Journal of India" in its new form continues to gain in popularity, and it is issued once every two months, instead of quarterly, from the 1st January, 1920.

Provincial. The United Provinces department of agriculture issued pamphlets on implements and manures, and revised and brought up-to-date the existing cultivators' leaflets on American cotton growing and potato storage. Mr. B. C. Burt published a bulletin on Cawnpore-American cotton (Pusa Bulletin No. 88). Two monthly agricultural journals—*Mufid-ul-Muzarain* and *Kisan-upakarak*, in Urdu and Hindi, respectively—were also issued regularly.

In Bombay, one bulletin on the cultivation of berseem in Sind and eleven leaflets on various subjects were issued by the department. Two bulletins, one on the classification and description of *jowars* of the Bombay Karnatak, and the other on palm *gul* manufacture in the Presidency, were in the press at the close of the year. The "Poona Agricultural College Magazine" and also the Marathi, Kanarese and Gujarati periodicals continued to be issued.

In Madras, four leaflets in English and in the vernacular languages were issued. The publication of the Departmental Year Book, and the Agricultural Calendar in English and in the four vernaculars of the Presidency was continued. Two bulletins and a description of the common fodder grasses of South India were published during the year, while Dr. Barber contributed two papers which were issued as memoirs (Botanical Series, Vol. X, Nos. 2 and 3), and Messrs. Visawanath, Rao and Ayyangar contributed a paper which was published as a memoir in the Chemical Series, Vol. V, No. 4.

In the Central Provinces, a series of popular bulletins for farmers, on the lines of those published in America, is being issued in English and the vernaculars. Three such bulletins on the irrigation of wheat, the use of cattle dung for manuring and the use of nitrate of soda for cotton have already been issued and five others have been in the press. A book entitled "Lessons on Indian Agriculture" for use in agricultural middle schools and an agricultural story book were also in the press at the close of the year.

The Burma Department of Agriculture issued 3 leaflets during the year.

In Mysore, besides the Agricultural Calendar and the Proceedings of the Fourth Departmental Conference, 3 bulletins and 7 circulars were issued during the year.

A complete list of agricultural publications issued during the year is given as Appendix VI, pages 172—186.

CHAPTER VIII.

EXPENDITURE.

The total expenditure incurred by the Imperial Department of Agriculture during the financial year 1918-19 was Rs. 6,06,640, as against Rs. 5,81,723 during the previous year. The details are given below :—

	Rs.
Office of the Agricultural Adviser and Director	2,35,301
Chemical Section	38,129
Mycological Section	42,954
Entomological Section	55,073
Pathological Entomological Section	38,131
Bacteriological Section	32,860
Botanical Section	50,327
Agricultural Section	63,594
Indigo Research Section	50,271
TOTAL	6,06,640

A sum of Rs. 15,000 was paid as a grant-in-aid to the Indian Tea Association.

The principal items of expenditure under the annual grant of Rs. 10,000 placed at the disposal of the Agricultural Adviser to the Government of India for special agricultural experiments were as follows :—

	Rs.
Purchase of a corn crusher	655
Purchase of a chaff cutter	596
Purchase of canvas paulins for the Pusa farm	652
Paid to the Director of Agriculture, Bengal, for the cost of a mechanical fibre extractor	1,457
Experimental cotton cultivation by the Imperial Cotton Specialist	1,200
Pay of a Veterinary Assistant in connection with cattle-breeding and that of a Field-man for mosquito experiments	1,431

The expenditure incurred in the working of the Imperial Bacteriological Laboratory at Muktesar during the financial year 1918-19 was Rs. 4,37,712 as against Rs. 3,36,481 in the previous year. The principal items of expenditure were as follows :—

	Rs.
Salaries and travelling allowances of officers and staff	1,07,963
Feed and upkeep of animals	1,97,557
Purchase of animals	43,894
Cost of chemicals and apparatus	31,892
Miscellaneous expenditure	56,406
TOTAL	4,37,712

The total expenditure which the Provincial Departments of Agriculture incurred during the year amounted to Rs. 69,07,830 as against Rs. 52,14,031 during 1917-18. The details are shown below :—

	Rs.
Bengal	8,10,000
Bihar and Orissa	4,25,759
United Provinces	10,85,020*
Punjab	10,52,434†
Bombay	12,57,000
Madras	10,11,494
Central Provinces	6,08,102
Burma	3,57,551‡
Assam	2,45,298
North-West Frontier Province	40,733§
Baluchistan	14,439
TOTAL	69,07,830

* Including the cost of acquiring land and opening new farms.

† Including Rs. 1,05,139 on account of buildings.

‡ Including Rs. 1,48,430 which represented contributions to botanical and other public gardens.

§ Excluding agricultural scholarships.

APPENDIX I.

List of Agricultural Stations in British India.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Imperial . .	Pusa, Bihar . .	Overseer . . .	Imperial Agriculturist, Agricultural Research Institute, Pusa.	
Bombay	Surat . . .	Superintendent . .	Deputy Director of Agriculture, Northern Division, Poona.	
	Nadiad .	Overseer . .	Ditto	Fodder farm.
	Dohad .	Superintendent . .	Ditto	
	Dhulia . .	Ditto . . .	Ditto	
	Jalgaon . .	Ditto . .	Ditto	
	Kopargaon	Overseer .	Ditto	Fodder farm
	Dharwar	Superintendent . .	Deputy Director of Agriculture, Southern Division, Dharwar.	
	Gadag . . .	Overseer . . .	Ditto	
	Gokak Canal .	Superintendent . .	Ditto	
	Tegur . .	Divisional Inspector of Agriculture, Southern Division.	Ditto	Cattle-breeding farm.
	Alibag . .	Superintendent . .	Deputy Director of Agriculture, Konkan, Ratnagiri.	

List of Agricultural Stations in British India—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Bombay—*contd.*	Ratnagiri	Superintendent	Deputy Director of Agriculture, Konkan, Ratnagiri.	
	Kumpta	Ditto	Ditto	
	Mirpurkhas	Ditto	Deputy Director of Agriculture, Sind, Mirpurkhas.	Seed farm
	Mirpurkhas	Ditto	Ditto	
	Sukkur	Ditto	Ditto	
	Larkana	Ditto	Ditto	
	Landhi	Ditto	Ditto	
	Ganeshkhind, Kirkee	Ditto	Economic Botanist, Poona	Botanical Station.
	Poona	Ditto	Professor of Agriculture, Poona Agricultural College.	Agricultural College farm.
	Kirkee	Manager	Ditto	Agricultural College dairy.
	Manjri	Superintendent	Ditto	Sugarcane Experiment Station.
	Coimbatore	Manager	Principal, Agricultural College and Research Institute and Superintendent, Central Farm, Coimbatore.	Central farm attached to the Agricultural College.
	Samalkota	Ditto	Deputy Director of Agriculture, I Circle.	
	Anakapalle	Ditto	Ditto	

Madras	Hagari	Manager	Deputy Director of Agriculture, II-III Circles.	
	Bantanahal	Ditto	Ditto	Sheep farm
	Sirvel	Ditto	Assistant Director of Agriculture, II-III Circles.	
	Nandyal	Ditto	Ditto	
	Palur	Ditto	Deputy Director of Agriculture, IV Circle.	
	Gudiyattam	Ditto	Ditto	Demonstration farm.
	Koilpatti	Ditto	Deputy Director of Agriculture, VI Circle.	
	Manganallur	Ditto	Deputy Director of Agriculture, V and VII Circles.	
	Taliparamba	Ditto	Ditto	
	Kasaragod	Ditto	Ditto	Coconut station.
	Anamalais	Ditto	Ditto	Cotton farm.
	Tenmalai (Travancore)	Ditto	Deputy Director of Agriculture, Planting Districts.	Rubber stations.
	Mooply (Cochin)	Ditto		
	Sidapur (Coorg)	Ditto		Coffee station.
	Peermade	Ditto		Tea station.
	Chintaladevi	Ditto	Deputy Director of Agriculture for Live stock.	Cattle farm.
Bengal	Dacca	Superintendent	Deputy Director of Agriculture, Eastern Circle, Dacca.	Central farm.
	Mymensingh	Ditto		District farms.
	Comilla	Ditto		

List of Agricultural Stations in British India.—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Bengal—*contd.*	Rajshahi	Superintendent	Deputy Director of Agriculture, Western and Northern Circles, Calcutta.	
	Rangpur	Ditto		Cattle farm.
	Rangpur Demonstration Farm.	Ditto		
	Burirhat (Rangpur)	Ditto		Tobacco growing farm.
	Bogra	Ditto		
	Chinsurah	Ditto		
	Burdwan	Ditto		Private farm under the supervision of the Agricultural Department.
	Kalimpong	Manager		Private farm managed by St. Andrew's Colonial Homes.
	Berhampur	Superintendent of Sericulture	.....	Sericultural research stations.
	Kurseong			
	Kalimpong			
	Sabour	Superintendent	Professor of Agriculture	Home farm attached to the Agricultural College, Sabour.
	Dumraon	Ditto	Deputy Director of Agriculture, Patna Circle, Bankipore.	Private farm under the supervision of the Agricultural Department.
	Ranchi (Kanke)	Ditto	Deputy Director of Agriculture, Chota Nagpur Circle, Ranchi.	

Bihar and Orissa	Cuttack	Superintendent	Deputy Director of Agriculture, Orissa Circle, Cuttack.	
	Angul	Ditto		
	Jamurda (Sambalpur)	.....	....	Private farms under the advice of the Agricultural Department.
	Bharatpur (Kendrapara)	.....	.....	
	Nagpura (Kendrapara)	....	....,	
	Kanika Raj	.....	....	
	Sipaya	Superintendent	Superintendent	Cattle breeding farm.
United Provinces	Cawnpore	Inspector	Deputy Director of Agriculture, Central Circle, Cawnpore.	
	Kalianpur	Fieldman		Seed farm.
	Orai	Inspector		
	Altara	Divisional Superintendent of Agriculture.		
	Etawah	Inspector		Demonstration farms.
	Hardoi	Ditto		
	Mainpuri	Ditto		
	Partabgarh	Superintendent	Deputy Director of Agriculture, Eastern Circle, Partabgarh	Seed farm.
	Nangawan	Ditto		
	Fyzabad	Inspector		
	Benares	Inspector	Divisional Superintendent of Agriculture, Eastern Circle.	
	Aligarh	Ditto	Deputy Director of Agriculture, Western Circle, Aligrah.	
	Nawabganj (Bareilly)	Overseer		

List of Agricultural Stations in British India—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
United Provinces—*contd.*	Muzaffarnagar	Superintendent	Deputy Director of Agriculture, Western Circle, Aligarh.	District farms.
	Muttra	Overseer		
	Agra	Ditto		
	Saharanpur	Inspector		
	Bulandhshahr	Ditto		
	Kalai	Overseer		Seed farm.
	Gorakhpur	Ditto	Deputy Director of Agriculture, North-Eastern Circle, Gorakhpur.	
	Bahraich	Ditto		
Punjab	Lyallpur	Superintendent	Professor of Agriculture, Punjab Agricultural College.	
	Montgomery	Extra Assistant Director of Agriculture.	Ditto	Mainly a seed farm
	Gurdaspur	Manager	Deputy Director of Agriculture, Gurdaspur.	
	Sargodha	Ditto	Ditto	Seed farms.
	Chilianwalla	(Given to tenants)		
	Hansi	Manager	Deputy Director of Agriculture, Hansi.	
	Kahuta	Ditto	Agricultural Chemist, Punjab	For reclamation of saline soils.

Burma	Mandalay	Superintendent	Deputy Director of Agriculture, Northern Circle, Mandalay.	
	Padu	Overseer	Ditto	Sub-stations.
	Bugyi	Ditto	Ditto	
	Hopin	Ditto	Ditto	
	Yawn ghwe	Ditto	Ditto	
	Hsum Hsai	Ditto	Ditto	
	Hmawbi	Superintendent	Deputy Director of Agriculture, Southern Circle, Insein.	
	Tatkon	Ditto	Ditto	
	Nyaunglebin (Pegu)	Overseer	Ditto	
	Yodashe (Toungoo)	Ditto	Ditto	District farms.
	Zigon (Tharrawaddy)	Ditto	Ditto	
	Thilawa (Hanthawaddy)	Ditto	Ditto	
	Taungtha (Myingyan)	Ditto	Ditto	
	Pakokku	Ditto	Ditto	
	Pwinbyu (Minbu)	Ditto	Ditto	
	Allanmyo (Thayetmyo)	Ditto	Ditto	
Central Provinces	Nagpur	Superintendent	Principal, Agricultural College, Nagpur.	
	Akola	Ditto	Deputy Director of Agriculture, Western Circle, Nagpur.	
	Borgaon	Ditto	Ditto	Cattle breeding farm.

List of Agricultural Stations in British India—contd.

Name of Province	Name of the Agricultural Station	Officer in immediate charge	Supervising Officer	Remarks
Central Provinces—*contd.*	Basim	Superintendent	Deputy Director of Agriculture, Western Circle, Nagpur.	Seed and Demonstration farm.
	Sindewahi	Ditto	Deputy Director of Agriculture, Southern Circle, Nagpur.	Experimental and cattle breeding farms.
	Chandkhuri	Ditto	Ditto	
	Labhandi (Raipur)	Ditto	Ditto	
	Tharsa	Ditto	Ditto	
	Warasconi (Balaghat)	Ditto	Ditto	Seed and demonstration farms.
	Sarkhanda (Bilaspur)	Ditto	Ditto	
	Ruabanda (Drug)	Ditto	Ditto	Seed and demonstration, and cattle-breeding farms.
	Raigarh	Ditto	Ditto	Cattle breeding farms.
	Bilaspur	Ditto	Ditto	
	Telinkheri (Nagpur)	Ditto	Ditto	Diary farm.
	Powarkhera (Hoshangabad).	Ditto	Deputy Director of Agriculture, Northern Circle, Jubbulpore.	Experimenal and cattle-breeding farms.
	Adhartal (Jubbulpore)	Ditto	Ditto	
	Chhindwara	Ditto	Ditto	Experimenal farm.
	Kheri (Jubbulpore)	Ditto	Ditto	Cattle breeding farm.

	Betul	Ditto	Ditto	Seed and demonstration farms.
	Seoni	Ditto	Ditto	
	Saugar	Ditto	Ditto	
	Damoh	Ditto	Ditto	
Assam	Jorhat	Manager	Deputy Director of Agriculture, Assam Valley, Jorhat.	
	Kamrup	Ditto	Ditto	
	Upper-Shillong	Ditto	Ditto	
	Karimganj	Ditto	Deputy Director of Agriculture, Surma Valley, Sylhet.	
	Shillong (Fruit Experiment Station).	Superintendent	Ditto	
North-West Frontier Province.	Tarnab (Peshawar)	Manager	Agricultural Officer, North-West Frontier Province, Peshawar.	
	Haripur	Ditto	Ditto	

APPENDIX II.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1918-19.

The two tables below include Agricultural Societies for—

A. 1. *Purchase, and Purchase and Sale.* These are societies intended to facilitate the purchase of agricultural requisites for members, such as societies which purchase seed, manure, implements, etc., for sale to their members. Societies of this character which also collect for joint sale the produce of members without making this their main object are included in this class.

2. *Production.* These are societies which have for their chief object an act of production without proposing to themselves sale as a direct object. This also includes societies for joint irrigation, for collective use of machinery, for assistance in horse and cattle breeding, etc.

3. *Production and Sale.* This class includes societies in which these two functions are united or in which one or the other predominates, it being impossible to make a clear distinction between them. It covers all societies whose main object is the joint sale of any commodity whether such commodity is produced or worked up or prepared for sale by the society itself or by the members individually. It comprises all co-operative creameries, and distilleries, as well as societies whose main object is the sale of grain, cattle, eggs, *ghee*, etc., produced by their members.

4. Other forms of co-operation except insurance.

B. Insurance.

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1918-19—contd.

(A) *Purchase, Sale and Production.*

Province	Class of societies	Number of societies.	Number of members	Sale of goods to members	Purchase of members' products.	Working Capital	Profit and loss for the year.	Remarks
				Rs.	Rs.	Rs.	Rs.	
Bombay	Purchase and Purchase and Sale.	23	1,143	67,466	8,176	52,357	+5,018	
	Production	11	374	2	638	1,402	—230	
	Production and Sale	42	4,117	47,138	13,17,392	1,19,602	+16,903	
	Others	13	568	4,158	685	20,735	+88	
	Total	89	6,202	1,18,764	13,26,891	1,94,096	+21,779	
Madras	Purchase and Purchase and Sale.	31	1,891	24,559	3,86,079	63,999	+1,344	
	Production and Sale	2	23	..	..	610	+401	
	Total	33	1,914	24,559	3,86,079	64,609	+1,745	
Bengal	Purchase and Purchase and Sale.	5	2,628	82,260	69,198	67,676	+4,123	
	Production	1	100	..	..	4,209	+85	
	Production and Sale	23	3,556	32,862	4,80,590	6,97,232	+3,01,786	
	Total	29	6,284	1,15,122	5,49,788	7,69,117	+3,05,994	

Operations of Non-Credit Agricultural Co-operative Societies in British India during 1918-19—concld.

(A) *Purchase, Sale and Production*—concld.

Province	Class of societies	Number of societies	Number of members	Sale of goods to members	Purchase of members' products	Working Capital	Profit and loss for the year	Remarks
				Rs.	Rs.	Rs.	Rs.	
Bihar and Orissa	Purchase and Purchase and Sale.	2	35	..	..	149	+18	Agricultural Associations.
	Production and Sale	1	33	1,567	1,374	3,134	+150	
	Total	3	68	1,567	1,374	3,283	+168	
United Provinces	Purchase and Purchase and Sale.	1	67	..	4,183	6,338	+1,609	
	Production and Sale	8	340	..	17,446	27,858	+1,200	
	Total	9	407	..	21,629	34,196	+2,809	
Punjab	Purchase and Purchase and Sale.	102	1,234+971*	2,28,462	..	1,72,098	+5,306	*Societies.
	Production and Sale	39	830	64,313	14,436	19,287	—352	
	Total	141	2,064+971*	2,92,775	14,436	1,91,387	+4,954	
Burma	Purchase and Purchase and Sale.	9	361	..	..	..	..	
	Production and Sale	50	3,555	32,022	1,01,991	29,232	+5,428	
	Others	27	402	..	..	..	..	
	Total	77	3,957	32,022	1,01,991	29,232	+5,428	

Central Provinces and Berar	Purchase and Sale	4	125	9,808	..	7,052	+1,508
	Production . . .	31	420	552	..	15,256	+1,357
	TOTAL .	35	545	10,360	..	22,308	+2,865

(B) *Cattle Insurance.*

PROVINCE	Number of societies	Amount of risk insured	Premia collected during the year	Supplementary contribution collected	NUMBER OF ANIMALS.		Claims paid	Cost of management	Funds in hand at end of year	Amount of risk re-insured	Amount of premia paid for re-insurance
					Insured	Lost					
		Rs.	Rs.	Rs.			Rs.	Rs.	Rs.	Rs.	Rs.
Bombay . .	4	4,955	194	..	76	1	161	85	625	...	...
Bengal . . .	1	175	..	..	...	...	...	...	28	...	...
United Provinces .	1	322	..	..	31	...	...	...	36	...	...
Punjab . . .	8	29,270	801	..	372	3	166	49	852	782	51
Burma . .	386	2,15,398	8,144	..	5,988	249	5,074	717	27,889	1,07,699	3,798
	1*	1,07,699	3,798	..	5,985	249	2,233	824	14,913	...	...

* Central Re-insurance Society.

APPENDIX III.

List of Agricultural Colleges and Schools in British India during 1918-19.

Province	Name of College or School	Location of College or School	Number of Students on the Roll	College Staff	Remarks
			(a) Post-graduate Training Institution.		
....	Agricultural College, Pusa.	Pusa, Bihar . .	..	Director, Agricultural Research Institute, Pusa, is also the Principal. Imperial Agriculturist. Imperial Agricultural Chemist. Imperial Economic Botanist. Imperial Mycologist. Imperial Entomologist. Imperial Pathological Entomologist. Imperial Agricultural Bacteriologist.	Short courses in Sericulture and Lac-culture are temporarily given. The former course is for 1 year and the latter course is for 6 months. There were 4 students undergoing training in Sericulture and 2 in Lac-culture during 1918-19.
			*(b) Provincial Agricultural Colleges.**		
Bombay . .	Poona Agricultural College	Poona . . .	144	Principal, Agricultural College and Professor of Chemistry. Professor of Agriculture. Assistant Professor of Agriculture. 2 Demonstrators in Agriculture. 1 Lecturer in Agriculture. Assistant Professor of Chemistry. Lecturer in Chemistry. Professor of Botany.	Affiliated to the University of Bombay who confer the Degree of B.Ag. on passed students. The course is for 3 years. Students before admission must have passed the Previous Examination of the Bombay University or a similar examination of any Indian University.

				Assistant Professor of Botany. Assistant Professor of Mycology. Assistant Professor of Dairying. Lecturer in Dairying. Assistant Professor of Physics and Mathematics. Assistant Professor of Entomology. Lecturer in Veterinary Science. Demonstrator in Veterinary Science. 4 Part-time Demonstrators in Horticulture. 1 Part-time Demonstrator in Botany.	A short course in Agriculture is also given to farmers' sons who know English but who are not qualified to take the University course in agriculture. This course lasts for 1 year.
Madras	Agricultural College, Coimbatore	Coimbatore	99	Principal, Agricultural College. Assistant Principal. Veterinary Assistant. Engineering Assistant. 3 Agricultural Assistants. Farm Office Manager. Government Agricultural Chemist. Senior Assistant to Agricultural Chemist. 4 Assistants to Agricultural Chemist. Government Mycologist. 3 Assistants to Mycologist. Government Economic Botanist. 2 Assistants to Economic Botanist. Government Entomologist. 3 Assistants to Entomologist. Government Lecturing Botanist. 2 Assistants to Lecturing Botanist.	Two courses of instruction are given :— (1) The first course (2 years) for Certificate of Proficiency in practical agriculture, and (2) The second course (18 months in continuation of the 1st course) for the Diploma or Licentiate in Agriculture. A short course of training in the diagnosis and treatment of common pests and diseases of rubber is given to Estate Writers.

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance, *i.e.*, Matriculation or the School Final Examination of Indian Universities.

List of Agricultural Colleges and Schools in British India during 1918-19—contd.

Provence	Name of College or School	Location of College or School	Number of Students on the Roll	College Staff	Remarks
		(*b*) *Provincial Agricultural Colleges**—contd.			
Central Provinces	Agricultural College, Nagpur.	Nagpur . .	73	Principal, Agricultural College. Farm Superintendent and Demonstrator in Agriculture. First Agricultural Assistant Lecturer. Second Agricultural Lecturer and Demonstrator. Third Assistant Lecturer and Demonstrator. Dairy Manager. Assistant Demonstrator in Agriculture. Economic Botanist. Assistant Lecturer in Botany. Agricultural Chemist. Assistant Lecturer in Chemistry. Lecturer in Entomology. Lecturer in Bacteriology. Senior Veterinary Assistant in charge Menagerie and Demonstrator in Veterinary Science. Lecturer in Surveying. Farm Engineering. This subject is taught with the help of External Lecturers and Demonstrators from the Public Works Department, the School of Engineering and the School of Handicrafts, Nagpur, and the Agricultural Staff of the College. A Professor of English.	The courses of instruction given are :— In Agriculture— (1) Four years course for the Licentiate of Agriculture, and (2) Two years Diploma course for the sons of malguzars and substantial cultivators who intend to manage their own lands, and to whom a full scientific course is unnecessary. In Dairying— (1) The Dairy Diploma course of two and a half years, and (2) The Dairy short course of six months.

Bihar and Orissa.	Agricultural College, Sabour.	Sabour (near Bhagalpur).	63	Principal and Agricultural Chemist. Professor of Agriculture. Economic Botanist. Assistant Economic Botanist. Assistant Professor of Agriculture. Assistant Professor of Entomology. Assistant Professor of Mycology. Assistant Professor of Chemistry and Physics. Assistant Professor of Botany. Demonstrator in Entomology. Demonstrator in Botany. Demonstrator in Chemistry and Physics. Demonstrator in Agriculture. Fieldman in Mycology. Fieldman in Entomology. Veterinary Science. In teaching this subject temporary assistance is given by the Veterinary Assistant, Bhagalpur.	The course of instruction given is one of two years Certificate. Besides this, short season courses (*Bhadoi* and *Rabi*) are given. Seven students attended these courses during 1918-19.
United Provinces.	Agricultural College, Cawnpore.	Cawnpore	110	Principal, Agricultural College, and Economic Botanist. Assistant Economic Botanist. Agricultural Chemist. Agricultural Engineer. Assistant to Principal and Farm Superintendent. 8 Lecturers. 5 Demonstrators. 1 Mechanical Instructor.	Two courses of instructions are given :— (1) Diploma (L.Ag.) course of 4 years, and (2) Two years' or Vernacular course.

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance, *i.e.*, Matriculation or the School Final Examination of Indian Universities.

List of Agricultural Colleges and Schools in British India during 1918-19—contd.

Province	Name of College or School	Location of College or School	Number of Students on the Roll	College Staff	Remarks
		(*b*) *Provincial Agricultural Colleges**—concld.			
Punjab	Punjab Agricultural College.	Lyallpur	118	Principal, Agricultural College and Professor of Agriculture. Assistant Professor of Agriculture. Teaching and Research Assistant of Agriculture. Demonstrator in Agriculture. Agricultural Assistants in charge of Vernacular Class. Professor of Chemistry. 2 Assistant Professors of Chemistry. Demonstrator in Chemistry. Lecture table Assistant of Chemistry. Professor of Botany. 2 Assistant Professors of Botany. 2 Teaching and Research Assistants of Botany. Assistant Professor of Entomology. Teaching and Research Assistant of Entomology. Demonstrator in Entomology. Lecturer in Physics and Mathematics. Lecturer in Veterinary Science. Lecturer in Land Administration and Revenue. Lecturer in Land Surveying.	Affiliated to the Punjab University. Two courses of instruction are given :— (1) Two years' course for Leaving Certificate ; and (2) Four years' course for the Degree of B.Sc. in Agriculture. Besides, there are : a Vernacular Class which lasts for 1 year only, a Teachers' class which lasts for one year and a Rural Economy class which lasts for a shorter period.

				Professor of Agricultural Engineering. 2 Assistants for Teachers' Class. Head Mechanic in Agricultural Engineering. Assistant Professor of English. Lecturer of Land Surveying.	
			(c) *Agricultural Middle Schools.*		
Central Provinces	Agricultural Middle School, Powarkhera.	Powarkhera Experimental Farm, District Hoshangabad.	Not known.	Headmaster (an experienced agricultural assistant). An Assistant Teacher (from the Education Department) with two years' training in agriculture.	
Do.	Agricultural Middle School, Chandkhuri.	Chandkhuri Experimental Farm, District Raipur.	Do.	Headmaster (an experienced agricultural assistant). An Assistant Teacher (from the Education Department) with two years' training in agriculture.	
			(d) *Vernacular Agricultural Schools.*		
Bombay . .	Vernacular Agricultural School, Loni (in Marathi).	Loni, District Poona	45	Head Master (A Graduate Fieldman, B.Ag. of Bombay University). Non-graduate Fieldman. Assistant Master.	2 years' course.

* The minimum qualification for admission to the Provincial Agricultural Colleges for the diploma course is ordinarily the Entrance, *i.e.*, Matriculation or the School Final Examination of Indian Universities.

List of Agricultural Colleges and Schools in British India during 1918-19—concld.

Province	Name of College or School	Location of College or School	Number of Students on the Roll	College Staff	Remarks
		(*d*) *Vernacular Agricultural Schools*—concld.			
Bombay . .	Vernacular Agricultural School, Devi-hosur (in Kanarese).	Devi-hosur, District Dharwar.	30	Head Master (A Graduate Fieldman, B.Ag. of Bombay University). Non-graduate Fieldman. Assistant Master.	2 years' course.
Do. . .	Vernacular Agricultural School, Veshvi, (Kolaba), (in Marathi).	Veshvi, District Kolaba.	21	Head Master (Agricultural Graduate). Non-graduate Fieldman. Assistant Master. Vernacular Teacher.	2 years' course.
Do. . .	Vernacular Agricultural School, Jambul (in Marathi).	Jambul, District Thana.	28	Head Master (A Graduate Fieldman, B.Ag. of Bombay University). Non-graduate Fieldman. Assistant Master. Vernacular Teacher.	2 years' course.
Do. . .	Vernacular Agricultural School, Mirpurkhas (in Sindhi).	Mirpurkhas, District Thar and Parkar, Sind.	8	Head Master (Agricultural Graduate).	1 year's course.

APPENDIX IV.

Table showing the Working of the Provincial Civil Veterinary Departments during 1918-19.

Province	No. of Superior Staff		Research.	Dispensaries and Hospitals.			District Staff and Work.						
	Imperial Service officers	Provincial Service Officers		No. of Hospitals and Dispensaries	No. of Veterinary Assistants employed	No. of Cases treated and Castrations performed	No. of Inspectors	No. of Veterinary Assistants	No. of outbreaks in which inoculation was undertaken	Cases treated and castrations performed	Deaths unin-oculated	Inoculations	Deaths after inoculations
Bombay	4	6(*a*)	Examination of Specimens, etc.	61	61	136,426	5	61	271	53,426	4,007	29,509	150
Madras	2	6(*b*)	Ditto	43	43	53,267	10(*g*)	43	864	32,352	23,391	131,071	574
Bengal	1	7(*c*)	Ditto	31	32	46,909	6(*h*)	75	599	58,025	9,733	72,067	415
Bihar and Orissa	1	1(*d*)	....	24	22	29,016	8	75	808	40,319	6,772	98,182	197
United Provinces	1	2(*d*)	Kumri, pleuro-pneumonia in sheep and goats, gillar barsati, Akrah, fowl-cholera, etc.	88	88	108,288	16(*i*)	105	405	51,044	7,771	45,023	72
Punjab	8	5(*e*)	Examination of Specimens, etc.	133	130	310,797	18	133	961	80,595	9,440	191,852	253
Burma	1	3(*f*)	Ditto	1	1	2,184	19	185	529	79,596	6,558	64,824	838
Central Provinces	1	3(*f*)	Ditto	80	80	229,396	12(*j*)	20	662	121,571	7,605	73,859	178
Assam	1	..	Ditto	3	3	4,272	3	39	201	54,156	1,912	20,394	34
North-West Frontier Province	1	..	Ditto	17	18	45,281	3	18	117	26,830	1,008	29,998	49
Sind	1	1(*f*)	Ditto	15	14	22,135	...	14	27	4,679	828	2,637	14
Baluchistan			Ditto	5	5	6,654	1	5	3	4,319	171	387	...
Ajmer-Merwara				2	3	1,419	...	3	...	365	...	...	...
Total for 1918-19	22	34		503	500	996,044	101	776	5,447	607,277	79,196	759,803	2,774
Total for 1917-18	23	26		478	479	1,147,494	96	718	5,412	747,941	76,273	686,147	2,211

(*a*) 2 Deputy Superintendents, 2 Indian Professors and Assistant Professors.
(*b*) 4 Deputy Superintendents, 1 Assistant Principal and 1 Lecturer.
(*c*) 1 Deputy Superintendent, 1 Officiating Assistant Principal and 5 Lecturers.
(*d*) 1 Deputy Superintendent.
(*e*) 2 Deputy Superintendents, 2 Professors and 1 House Surgeon.
(*f*) Deputy Superintendents.
(*g*) The total strength was 16. Of these, 1 was attached to the Cattle Quarantine Department, 3 to the Veterinary College and 2 to the Agricultural College.
(*h*) The total strength was 16, of which 6 was employed in district work, 1 in hospital and 9 in other works.
(*i*) The total strength was 20, of which 2 are employed as Farm Overseers and 2 as Overseers in charge of Research Station and Stallion Depôt.
(*j*) Excluding 3 lent to Military Department.

APPENDIX V.

Table showing the details as to Students of Veterinary Colleges and Schools in India during 1918-19.

Veterinary Colleges and Schools	Name of Course of instruction	Number of Students						Students admitted during the year, classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at end of the year		Matriculates, School finals or with higher qualifications	Knowing some English but not Matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary Course	Instruction prolonged by reason of failure to pass			
1	2	3	4	5	6	7	8	9	10	11
Bombay	3 years' English Course.	12	24	33	11	77	27	16	20	..
Madras	Ditto	32	..	19	7	84	18	32	..	..
Bengal	Ditto	54	13	33	18	78	38	14	53	..
Punjab	3 years' Vernacular Course.	13	39	57*	10†	73	31	..	19	33
	4 years' Vernacular Course.	6	20	..‡	..	61	9	..	26	..
	Post-graduate Course.	..	..	..	..	..	..	..	..	..

* Includes 17 passed in April 1918 who belonged to the 4-year Course but were passed into the Army.

† 4 failed in one subject only, passed in June 1919.

‡ There was no 4-years' class due to 17 men passed to Army in 1918. Out of 21 of the 3-years' class in 4-years' Course, 19 passed in April 1919 and one passed on re-examination.

Table showing the details as to Students of Veterinary Colleges and Schools in India during 1918-19—concld.

Veterinary Colleges and Schools	Name of Course of instruction	Number of Students						Students admitted during the year, classed by educational qualifications		
		Admitted during the year		Passed final examination during the year	Failed to pass final examination	Remaining under instruction at end of the year		Matriculates, School finals or with higher qualifications	Knowing some English but not Matriculates	Knowing no English or very little English
		Scholarship holders	Others			In ordinary Course	Instruction prolonged by reason of failure to pass			
1	2	3	4	5	6	7	8	9	10	11
Burma — Insein Veterinary School.	3 years' Vernacular Course.	21	..	12	6	42	6	..	..	21
Burma — Taunggyi Veterinary School.	1½ years' Vernacular Course.	6	..	2	..	6	..	..	..	6
Total for 1918-19	....	144	96	156	52	421	129	62	118	60
Total for 1917-18	....	117	97	137	38	337	127	59	104	31

APPENDIX VI.

List of Agricultural Publications in India during 1918-19.

No	Title	Author	Where published
	GENERAL AGRICULTURE.		
1	The *Agricultural Journal of India*, Vol. XIII, Parts III and IV and Vol. XIV, Parts I and II. Price, Rs. 2 or 3*s.* per part; annual subscription Rs. 6 or 8*s.* 6*d.*	Edited by the Agricultural Adviser to the Government of India, Pusa.	Messrs. Thacker Spink and Co., Calcutta.
2	Special Indian Science Congress Number of the Agricultural Journal of India, 1919, Vol. XIV, Part III. Price Rs. 2 or 3*s.*	Ditto	Ditto
3	Scientific Reports of the Agricultural Research Institute, Pusa (including the Report of the Imperial Cotton Specialist) for 1917-18. Price Rs. 1-4 or 2*s.*	Issued from the Agricultural Research Institute, Pusa.	Government Printing, India, Calcutta.
4	Report on the Progress of Agriculture in India for 1917-18. Price Rs. 1-8 or 2*s.* 3*d.*	Agricultural Adviser to the Government of India, Pusa.	Ditto
5	Progress of the sugarcane industry in India during the years 1916 and 1917, being notes submitted to the meeting of the Board of Agriculture in India, Poona, 1917. Pusa Agricultural Research Institute Bulletin No. 83. Price As. 5 or 6*d.*	Edited, with an introduction, by C. A. Barber, C.I.E., SC.D., F.L.S., Chairman of the Sugar Committee of the Board of Agriculture in India, 1917.	Ditto
6	The best means of rapidly increasing the Outturns of Food Crops by methods within the power of the Agricultural Department, being notes submitted to the meeting of the Board of Agriculture in India, Poona, 1917. Pusa Agricultural Research Institute Bulletin No. 84. Price As. 4 or 5*d.*	Issued from the Agricultural Research Institute, Pusa.	Ditto
7	Soil Drainage. Pusa Agricultural Research Institute Bulletin No. 85. Price As. 4 or 5*d.*	R. G. Allan, M.A., Principal, Agricultural College, Nagpur.	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
8	Cawnpore-American Cotton: An account of experiments in its improvement by pure line selection and of field trials, 1913-17. Pusa Agricultural Research Institute Bulletin No. 88. Price As. 10 or 1*s.*	B. C. Burt, B.Sc., Deputy Director of Agriculture, Central Circle, United Provinces, Cawnpore; and Nizamuddin Haider, Subordinate Agricultural Service, United Provinces.	Government Printing, India, Calcutta.
9	The Future Prospects of the Natural Indigo Industry. The effect of superphosphate manuring on the yield and quality of the Indigo plant. Pusa Agricultural Research Institute Indigo Publication No. 4. Price As. 4 or 5*d.*	W. A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist to the Government of India.	Ditto
10	Annual Report of the Board of Scientific Advice for India for the year 1917-18. Price As. 14 or 1*s.* 3*d.*	Issued by the Board of Scientific Advice for India.	Ditto
11	Agricultural Statistics of India, 1916-17. Vols. I and II. Price Rs. 2 and R. 1 respectively.	Issued by the Department of Statistics, India.	Ditto
12	Agricultural Statistics of British India, 1917-18. Price As. 4 or 5*d.*	Ditto	Ditto
13	Estimates of Area and Yield of Principal Crops in India, 1917-18. Price As. 8.	Ditto	Ditto
14	Summary Tables of Agricultural Statistics of British India, 1917-18. Price As. 4 or 5*d.*	Ditto	Ditto
15	Prices and Wages in India, Thirty-fourth issue. Price Rs. 2 or 3*s.*	Ditto	Ditto
16	Quinquennial Report on the average yield per acre of principal crops in India for the period ending 1916-17. Price As. 12 or 1*s.* 2*d.*	Ditto	Ditto
17	Agricultural Statistics of Bengal for 1917-18. Price Rs. 1-8 or 2*s.* 3*d.*	Government of Bengal, Revenue Department.	Bengal Secretariat Book Depôt, Calcutta.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
18	Annual Report of the Department of Agriculture, Bengal, for the year 1917-18. Price As. 4 or 6*d.*	Issued by the Department of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
19	Season and Crop Report of Bengal for 1918-19. Price Rs. 1-5 or 2*s.*	Ditto	Ditto
20	Annual Reports of Expert Officers of the Department of Agriculture, Bengal, for the year 1917-18. Price Rs. 1-12 or 2*s.* 0*d.*	Ditto	Ditto
21	*Krishi Samachar.* Price As. 12.	Ditto	Ditto
22	Rules for the organization of Village Agricultural Associations (English).	Ditto	Ditto
23	Departmental Records : Some suggestions as to the organization of agricultural exhibitions in Bengal (Reprinted for official use only).	E. J. Woodhouse, Economic Botanist, Bengal.	Ditto
24	Annual Report of the Department of Agriculture, Bihar and Orissa, for the year ending 30th June, 1918. Price As. 6 or 6*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Bihar and Orissa Government Press, Patna.
25	Report on the Agricultural Activities of Government in Bihar and Orissa, for the year ending 30th June, 1918. Price Rs. 1-6 or 1*s.* 10*d.*	Ditto	Ditto
26	Season and Crop Report of Bihar and Orissa for 1918-19. Price Re. 1 or 1*s.* 4*d.*	Ditto	Ditto
27	Agricultural Statistics of Bihar and Orissa for 1917-18, Price As. 12 or 1*s.*	Ditto	Ditto
28	Report on the Administration of the Agricultural Department of the United Provinces of Agra and Oudh for the year ending 30th June, 1918. Price As. 6 or 6*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
29	Season and Crop Report of the United Provinces of Agra and Oudh for 1917-18. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
30	Report on the Agricultural Stations of the Western Circle, United Provinces of Agra and Oudh, for the year ending 30th June, 1918. Price As. 8 of 9*d.*	Ditto	Ditto
31	Report on the Agricultural Experiment stations in the Central Circle, United Provinces, for the year ending 30th June, 1918. Price Re. 1 or 1*s.* 6*d.*	Ditto	Ditto
32	Combined Annual Report of Partabgarh and Benares Agricultural Stations, United Provinces, for the year ending 30th June, 1918. Price As. 6 or 6*d.*	Ditto	Ditto
33	Notes on improved methods of cane cultivation. United Provinces Department of Agriculture Bulletin No. 35 (Revised).	G. Clarke, C.I.E., Agricultural Chemist, United Provinces, and Naib Hussain.	Ditto
34	Annual Report of the Department of Agriculture, Punjab, for the year ending 30th June, 1918. Price Re. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
35	Season and Crop Report of the Punjab for the year 1917-18. Price As. 14 or 1*s.* 2*d.*	Ditto	Ditto
36	Tables of the Agricultural Statistics of the Punjab for the year 1917-18.	Ditto	Ditto
37	Annual Report of the Lawrence Gardens for 1918-19. Price As. 2 or 2*d.*	Ditto	Ditto
38	Annual Report of the Department of Agriculture, Bombay Presidency, for 1917-18. Price As. 12 or 1*s.* 2*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
39	Season and Crop Report of the Bombay Presidency for 1917-18. Price As. 5 or 6*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
40	First Report on Fruit Culture as practised round about Tharushah in Nawabshah District, (Sind). Bombay Department of Agriculture Bulletin No. 88 of 1918. Price As. 2 or 2*d.*	Mohamed Umar Khan F. Barakyai, D. Ag., Agricultural Department, Sind.	Yeravda Prison Press, Poona.
41	Artificial manures: Experiments on their value for crops in Western India, No. II. Bombay Department of Agriculture Bulletin No. 89 of 1918. Price As. 3 3*p.* or 4*d.*	Harold H. Mann, D.Sc., Principal, Poona Agricultural College, and S. R. Paranjpe, B.Ag.	Ditto
42	The Treatment of Wounds and Cavities of old Mango Trees. Bombay Department of Agriculture Leaflet No. 4 of 1918.	Issued by the Department of Agriculture, Bombay.	Ditto
43	Increasing the Production of irrigated Wheat and Jowar. Bombay Department of Agriculture Leaflet No. 6 of 1918.	Ditto	Ditto
44	Prickly Pear as Fodder. Bombay Department of Agriculture Leaflet No. 7 of 1918.	Ditto	Ditto
45	The cultivation of Cape gooseberry or *Tiparee*. Bombay Department of Agriculture Leaflet No. 9 of 1918.	Ditto	Ditto
46	Maize as an Emergency Fodder Crop. Bombay Department of Agriculture Leaflet No. 10 of 1918.	Ditto	Ditto
47	Plantain stalks as fodder for cattle in famine years. Bombay Department of Agriculture Leaflet No. 1 of 1919.	Ditto	Ditto
48	Calendar of the Agricultural College, Poona, for 1918-19.	Ditto	Ditto
49	Report on the Operations of the Department of Agriculture, Madras Presidency, for the official year 1917-18. Price As. 6 or 6*d.*	Issued by the Department of Agriculture, Madras.	Government Press, Madras.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
50	Season and Crop Report of the Madras Presidency for 1917-18. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
51	The Madras Agricultural Calendar for 1919-20. Price Anna 1.	Ditto	Ditto
52	Report of the work of the Anakapalle Agricultural Station for 1917-18. Price As. 1-6 or 2*d.*	Ditto	Ditto
53	Report of the work of the Taliparamba Agricultural Station for 1917-18. Price Anna 1 or 1*d.*	Ditto	Ditto
54	Report of the work of the Samalkota Agricultural Station for the year 1917-18. Price As. 2 or 2*d.*	Ditto	Ditto
55	Report of the work of the Palur Agricultural Station for the year 1917-18. Price As. 3 or 3*d.*	Ditto	Ditto
56	Report of the work of the Koilpatti Agricultural Station for the year 1917-18. Price Anna 1 or 1*d.*	Ditto	Ditto
57	Report of the work of the Hagari Agricultural Station for the year 1917-18. Price As. 1-6 or 2*d.*	Ditto	Ditto
58	Report of the work of the Coimbatore Agricultural Station for the year 1917-18. Price As. 2 or 2*d.*	Ditto	Ditto
59	Report of the work of the Manganallur Agricultural Station for the year 1917-18. Price As. 2 or 2*d.*	Ditto	Ditto
60	Report of the work of the Nandyal Agricultural Station for the year 1917-18. Price Anna 1 or 1*d.*	Ditto	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
61	Report of the work of the Sirvel Agricultural Station for the year 1917-18. Price Anna 1 or 1*d.*	Issued by the Department of Agriculture, Madras.	Government Press, Madras.
62	Report of the work of the Bantanahal Sheep and Seed Farm for 1917-18. Price Anna 1 or 1*d.*	Ditto	Ditto
63	Exhibit of food and industrial products made from local agricultural produce at the Madras Industrial Exhibition, December 1917. Madras Department of Agriculture Bulletin No. 76.	Rao Sahib M. R. Ramaswami Sivan, B.A., Assistant Agricultural Chemist, Agricultural College, Coimbatore.	Ditto
64	Note on simple machines for extracting plantain fibre. Madras Department of Agriculture Bulletin No. 77 (Revised edition of Bulletin No. 47.)	R. L. Proudlock	Ditto
65	Certificated Drivers for Ryots' Pumping Engines. Madras Department of Agriculture Leaflet No. 3 of 1918.	Issued by the Department of Agriculture, Madras.	Ditto
66	How to increase the yield of crops (Agricultural songs). Madras Department of Agriculture Leaflet No. 4 of 1918.	Ditto	Ditto
67	Graft mangoes: how to start and maintain a mango garden. Madras Department of Agriculture Leaflet No. 6 of 1918.	D. Balkrishna Murthi Garu, Acting Deputy Director of Agriculture, Madras.	Ditto
68	Report on the working of the Department of Agriculture, Central Provinces and Berar, 1917-18. Price Re. 1 or 1*s.* 6*d.*	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
69	Season and Crop Report of the Central Provinces and Berar for 1917-18. Price As. 8 or 9*d.*	Ditto	Ditto
70	Report on Agricultural Stations, Southern Circle, Central Provinces for 1917-18. Price As. 8.	Ditto	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
71	Report on Agricultural Stations, Northern Circle, Central Provinces, for 1917-18. Price As. 8.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
72	Report on Agricultural Stations, Western Circle, Central Provinces, for 1917-18. Price As. 8.	Ditto	Ditto
73	Report on the Experimental Farm attached to the Agricultural College, Nagpur, for 1917-18. Price As. 8.	Ditto	Ditto
74	Report on Demonstration Work in the Southern Circle, Central Provinces, for 1917-18. Price As. 8.	Ditto	Ditto
75	Report on Demonstration Work in the Northern Circle, Central Provinces, for 1917-18. Price As. 8.	Ditto	Ditto
76	Report on Demonstration Work in the Western Circle, Central Provinces, for 1917-18. Price As. 8.	Ditto	Ditto
77	Report on the Agricultural College, Botanical and Chemical Research and Maharajabagh Menagerie for 1917-18. Price As. 8.	Ditto	Ditto
78	Rice Selection in Chhatisgarh. Price As. 2.	Ditto	Ditto
79	Self help in Agriculture. Price As. 2.	Ditto	Ditto
80	The *Agricultural and Co-operative Gazette* (Monthly) from July 1918 to June 1919. Price As. 2 per copy.	Ditto	Shalom Press, Nagpur.
81	Report on the Operations of the Department of Agriculture, Burma, for 1917-18. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
82	Season and Crop Report of Burma for 1917-18. Price As. 10 or 11*d.*	Ditto	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
83	Annual Reports of the Agricultural Stations, the Assistant Botanist of the Northern Circle, the Assistant Entomologist and the Agricultural Chemist to the Government of Burma for 1917-18. Price Rs. 2 or 3*s.*	Issued by the Department of Agriculture, Burma.	Government Printing, Burma, Rangoon.
84	Proceedings of an Agricultural Conference held in Maymyo on the 20th May, 1919.	Ditto	Ditto
85	Proceedings of a Conference between Superintendents, Northern and Southern Shan States, and the Departments of Irrigation, Co-operative Credit and Agriculture held at Maymyo on the 18th, 19th, 20th, 23rd and 24th May, 1919.	Ditto	Ditto
86	Cultivators' Leaflet No. 49-Cold Weather Castor Seed (in English and Burmese).	Ditto	Ditto
87	Cultivators' Leaflet on potato cultivation in Kachin (Romanized character).	Ditto	Ditto
88	Annual Report of the Department of Agriculture, Assam, for the year ending 30th June, 1918. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
89	Season and Crop Report of Assam for the year 1918-19. Price As. 8 or 9*d.*	Ditto	Ditto
90	Annual Report of the Jorhat Agricultural Experiment Station for the year ending 30th June 1918.	Ditto	Ditto
91	Annual Report of the Upper Shillong Agricultural Experiment Station for the year ending 30th June, 1918.	Ditto	Ditto
92	Annual Report of the Kamrup Surgarcane Experiment Station for the year ending 30th June, 1918.	Ditto	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*contd.*		
93	Annual Report of the Karimganj Agricultural Experiment Station for the year ending 30th June, 1918.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.
94	Annual Report of the Fruit Experiment Station, Shillong, for the year ending 30th June, 1918.	Ditto	Ditto
95	Annual Report of the Agricultural Experiments and Demonstrations in Assam for the year ending 30th June, 1918.	Ditto	Ditto
96	Annual Report of the Tarnab and Haripur Agricultural Stations, North-West Frontier Province for the year ending 30th June, 1918.	Issued by the Department of Agriculture, North-West Frontier Province.	Government Press, Peshawar.
97	Report on the Season and Crops of the North-West Frontier Province for 1917-18. Price Re. 1 or 1*s.* 4*d.*	Ditto	Ditto
98	Improvements in the packing and transport of fruit in India. Quetta Fruit Experiment Station Bulletin No. 2 (Third Edition).	Albert Howard, C.I.E., M.A., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Second Imperial Economic Botanist.	Baptist Mission Press, Calcutta.
99	The saving of Irrigation water in wheat growing. Quetta Fruit Experiment Station Bulletin No. 4 (Second edition).	Ditto	Ditto
100	Review of the Progress of Agriculture in Central India, 1916—18.	Bernard Coventry, C.I.E., Agricultural Adviser to States in Central India.	Indore C. I. A. (Govt.) Press.
101	Annual Report of the Agricultural Department, Gwalior Government, for 1917-18.	Issued by the Department of Agriculture, Gwalior.	Alijah Darbar Press, Lashkar.
102	The Silo and Silage or Methods of protecting India's Cattle from Starvation.	Sam Higginbotham, M.A., Director of Agriculture, Gwalior.	Ditto
103	Report on the operations of the Department of Agriculture and Fisheries, Travancore, for 1917-18.	Issued by the Department of Agriculture and Fisheries, Travancore.	Government Press, Triplicane.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	GENERAL AGRICULTURE —*concld.*		
104	Mysore Agricultural Calendar for 1919. Price Anna 1.	Issued by the Department of Agriculture, Mysore.	Government Press, Bangalore.
105	*Quarterly Journal of the Indian Tea Association.* Price As. 6 per copy.	Issued by the Scientific Department of the Indian Tea Association.	Catholic Orphan Press, Calcutta.
106	The *Journal of the Madras Agricultural Students' Union* (Monthly). Annual Subscription Rs. 2.	Madras Agricultural Students' Union, Coimbatore.	Library Sun Press, Coimbatore.
107	The *Journal of Dairying and Dairy-Farming in India* (Quarterly). Subscription Rs. 5 per annum (including membership).	Published by the Indian Committee of the Dairy Education Association, Quetta.	Messrs. Thacker Spink and Co., Calcutta.
108	*Poona Agricultural College Magazine* (Quarterly). Annual Subscription Rs 2.	College Magazine Committee, Poona.	Arya Bhusan Press, Poona.
109	The *Planters' Chronicle* (Weekly).	United Planters' Association of South India.	Daily Post Press, Bangalore.
110	The *Indian Journal of Economics* (Quarterly). Annual Subscription Rs. 12.	Department of Economics, University of Allahabad.	Pioneer Press, Allahabad.
111	*Bengal Economic Journal* (Quarterly). Annual Subscription Rs. 10.	Bengal Economic Association.	The Calcutta General Printing Co., Ltd.
112	*Mysore Economic Journal* (Monthly). Annual Subscription Rs. 4.	Mysore Economic Conference.	Vokkaligara Press, Bangalore.
113	*Journal of the Mysore Agricultural and Experimental Union* (Quarterly). Annual Subscription Rs. 3.	Mysore Agricultural Experimental Union.	Bangalore Press, Bangalore.
	AGRICULTURAL CHEMISTRY.		
114	Experiments on the Improvement of the Date Palm Sugar Industry in Bengal. Memoirs of the Department of Agriculture in India, Chemical Series, Vol. V, No. 3. Price Re. 1 or 1s. 6d.	Harold E. Annett, B.SC., F.I.C., Agricultural Chemist to the Government of Bengal, and Gosto Behari Pal, M.SC., and Indu Bhushan Chatterji, Assistants to the Agricultural Chemist to the Government of Bengal.	Messrs. Thacker Spink and Co., Calcutta.

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	AGRICULTURAL CHEMISTRY—*concld.*		
115	Cholam (A. *Sorghum*) as a substitute for Barley in Malting Operations. Memoirs of the Department of Agriculture in India, Chemical series, Vol. V, No. 4. Price As. 12 or 1*s.*	B. Viswanath, T. Lakshmana Row, B.A., and P. A. Raghunathaswami Ayyangar, Dip. Ag., Assistants to the Government Agricultural Chemist, Madras.	Messrs. Thacker Spink and Co., Calcutta.
116	The improvement of the indigenous methods of *gur* and sugar making in the United Provinces. Pusa Agricultural Research Institute Bulletin No. 82. Price As. 8 or 9*d.*	W. Hulme, Sugar Engineer Expert to the Government of India, and R. P. Sanghi, Sugar Chemist, Nawabganj Experimental Factory.	Government Printing, India, Calcutta.
117	The loss of indigo caused by bad settling and the means of obviating this. The use of *dhak* gum—its effect on yield and quality. Pusa Agricultural Research Institute Indigo Publication, No. 3. Price As. 4 or 5*d.*	W.A. Davis, B.Sc., A.C.G.I., Indigo Research Chemist to the Government of India.	Ditto
118	An improved method of preparing indican from indigo-yielding plants. Pusa Agricultural Research Institute Indigo Publication No. 5. Price. As. 2 or 3*d.*	Bhailal M. Amin, B.A., First Assistant to the Indigo Research Chemist, Pusa.	Ditto
119	The composition of milk of the local Gwalior cows and its relation to the nature of food-stuff. Gwalior Chemical and Technical Laboratory Monograph II.	M. J. Gajjar, M.A., F.C.S., and F. B. Shroff, M.A.	Alijah Darbar Press, Gwalior.
	BOTANY.		
120	Studies in Indian Sugarcanes, No. 4. Tillering or underground branching. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 2. Price Rs. 4-4 or 7*s.*	C. A. Barber, C.I.E., Sc.D., F.L.S., Government Sugarcane Expert, Madras.	Messrs. Thacker Spink and Co., Calcutta.
121	The Date-plam and its Cultivation in the Punjab. Price Rs. 5.	D. Milne, B.Sc., Economic Botanist, Punjab.	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	MYCOLOGY.		
122	*Phytophthora Meadii* on *Hevea brasiliensis*. Memoirs of the Department of Agriculture in India, Botanical series, Vol. IX, No. 5. Price Rs. 1-4 or 2*s*.	W. McRae, M.A., B.SC., F.L.S., Government Mycologist, Madras.	Messrs. Thacker Spink and Co., Calcutta.
123	The Rice Worm (*Tylenchus angustus*) and its control. Memoirs of the Department of Agriculture in India, Botanical Series, Vol. X, No. 1. Price Rs. 1-4 or 2*s*.	E. J. Butler, M.B., F.L.S., Imperial Mycologist.	Ditto
124	A Stem Disease of Tea. Price As. 8.	Issued by the Scientific Department of the Indian Tea Association.	Star Printing Works, Calcutta.
	ENTOMOLOGY.		
125	*Moumachipalan.* (Bengali Version of Pusa Agricultural Research Institute Bulletin No. 46 on Beekeeping). Price As. 14 or 1*s*. 4*d*.	C. C. Ghosh, B.A., Assistant to Imperial Entomologist.	Baptist Mission Press, Calcutta.
126	*Resham shilper unnatikalpé tuntbhook Resham keetjati sambandhé Parikshar dwitiya bibaranee* (Bengali version of Pusa Agricultural Research Institute Bulletin No. 74). Price As. 12 or 1*s*.	M. N. De, Sericulture Assistant, Pusa.	Ditto
	VETERINARY.		
127	Annual Report of the Imperial Bacteriological Laboratory, Muktesar, for the year ending 31st March, 1918. Price As. 4 or 5*d*.	Issued by the Agricultural Adviser to the Government of India, Pusa.	Government Printing, India, Calcutta.
128	Are camels susceptible to Black Quarter, Hæmorrhagic Septicæmia and Rinderpest ? Pusa Agricultural Research Institute Bulletin No. 80. Price As. 4 or 5*d*.	H. E. Cross, M.R.C.V.S., D.V.H., A.SC., Camel Specialist to Government, Sohawa, Punjab.	Ditto

List of Agricultural Publications in India during 1918-19—contd.

No	Title	Author	Where published
	VETERINARY—*contd.*		
129	A new nematode causing parasitic gastritis in calves. Pusa Agricultural Research Institute Bulletin No. 86. Price As. 4 or 5*d.*	A. L. Sheather, B.SC., M.R.C.V.S., Director and First Bacteriologist, Imperial Bacteriological Laboratory, Muktesar.	Government Printing, India, Calcutta.
130	Statistics compiled by the Government of India from the Reports of Provincial Veterinary Departments for the year 1917-18.	Issued by the Revenue and Agricultural Department of the Government of India.	G. M. Press, Simla.
131	Annual Report of the Bengal Veterinary College and of the Civil Veterinary Department, Bengal, for 1917-18. Price As. 9 or 10*d.*	Issued by the Civil Veterinary Department, Bengal.	Bengal Secretariat Book Depôt, Calcutta.
132	Annual Report of the Civil Veterinary Department, Bihar and Orissa, for 1918-19. Price As. 10 or 10*d.*	Issued by the Department of Agriculture, Bihar and Orissa.	Government Press, Bihar and Orissa, Patna.
133	Annual Report of the United Provinces Civil Veterinary Department for the year ending 31st March, 1918. Price As. 8 or 9*d.*	Issued by the Department of Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
134	Household Dairying (in Marathi)	B. K. Ghare, L.AG., Lecturer, Agricultural College, Cawnpore.	Arya Bhusan Press, Poona.
135	Annual Report on the Punjab Veterinary College, Civil Veterinary Department, Punjab, and the Government Cattle Farm, Hissar, for 1917-18. Price As. 10 or 10*d.*	Issued by the Department of Agriculture, Punjab.	Government Printing, Punjab, Lahore.
136	Report of the Bombay Veterinary College and Civil Veterinary Department, Bombay Presidency including Sind, for 1917-18. Price As. 7 or 8*d.*	Issued by the Department of Agriculture, Bombay.	Government Central Press, Bombay.
137	Annual Administration Report of the Civil Veterinary Department, Madras Presidency, for 1917-18. As. 14 or 1*s.* 3*d.*	Issued by the Civil Veterinary Department, Madras.	Government Press, Madras.
138	Faulty flaying of hides and the branding of cattle. Madras Department of Agriculture Leaflet No. 5. of 1918.	Issued by the Department of Agriculture, Madras.	Ditto

List of Agricultural Publications in India during 1918-19—concld.

No	Title	Author	Where published
	VETERINARY—*concld.*		
139	Report on the Working of the Civil Veterinary Department, Central Provinces and Berar, for 1917-18. Price Re. 1 or 1*s* 6*d*.	Issued by the Department of Agriculture, Central Provinces and Berar.	Government Press, Central Provinces, Nagpur.
140	Report of the Civil Veterinary Department (including the Insein Veterinary School), Burma, for the year ending 31st March, 1918. Price As. 8 or 9*d*.	Issued by the Civil Veterinary Department, Burma.	Government Printing, Burma, Rangoon.
141	Cultivators' Leaflet No. 50. Instructions regarding the flaying and curing of hides for the guidance of Cattle Insurance Societies (In Burmese).	Ditto	Ditto
142	The branding, flaying and curing of hides. Burma Department of Agriculture Cultivators' Leaflet No. 51.	Issued by the Department of Agriculture, Burma.	Ditto
143	Report of the Civil Veterinary Department, Assam, for 1917-18. Price As. 8 or 9*d*.	Issued by the Department of Agriculture, Assam.	Assam Secretariat Printing Office, Shillong.

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